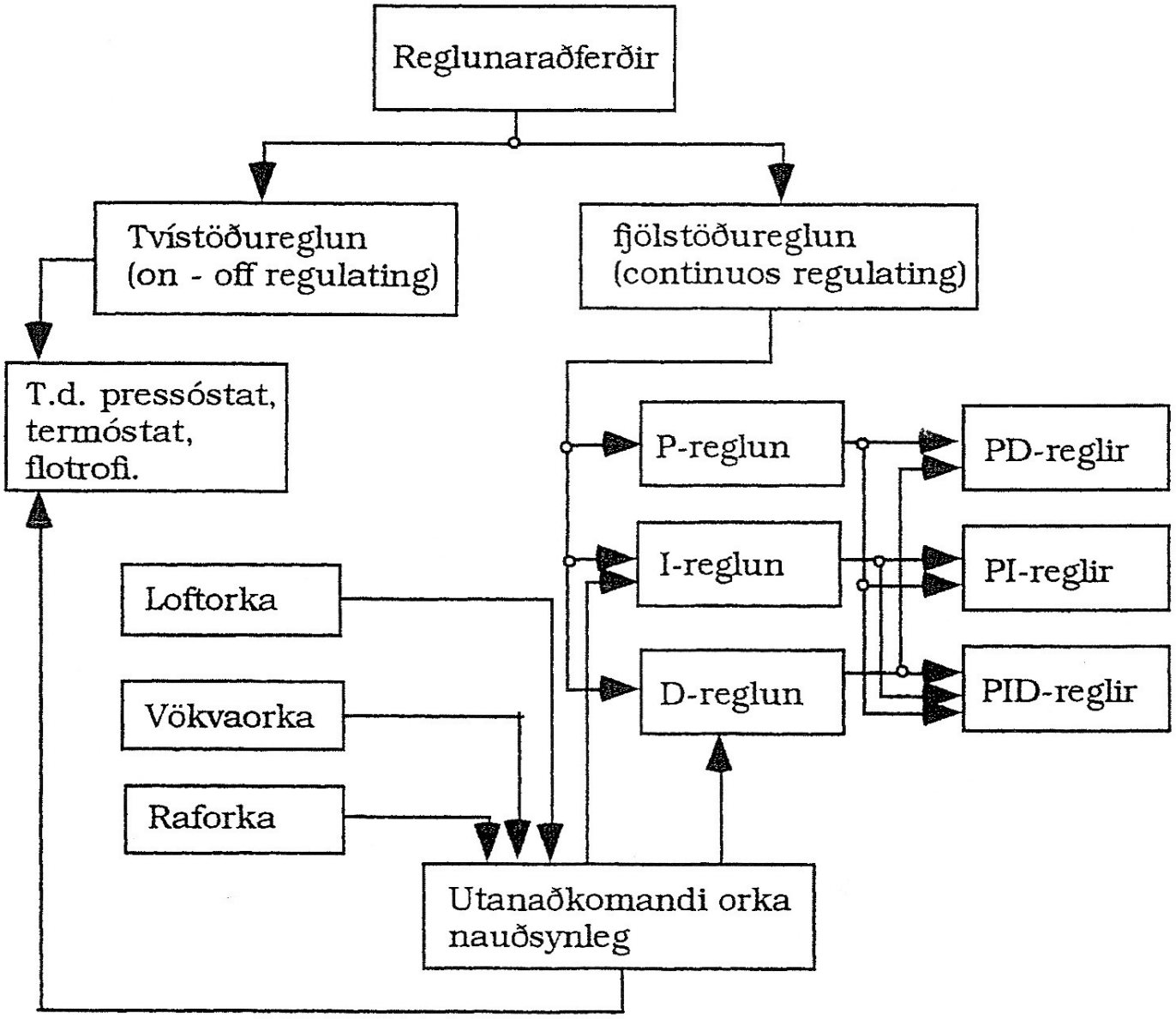
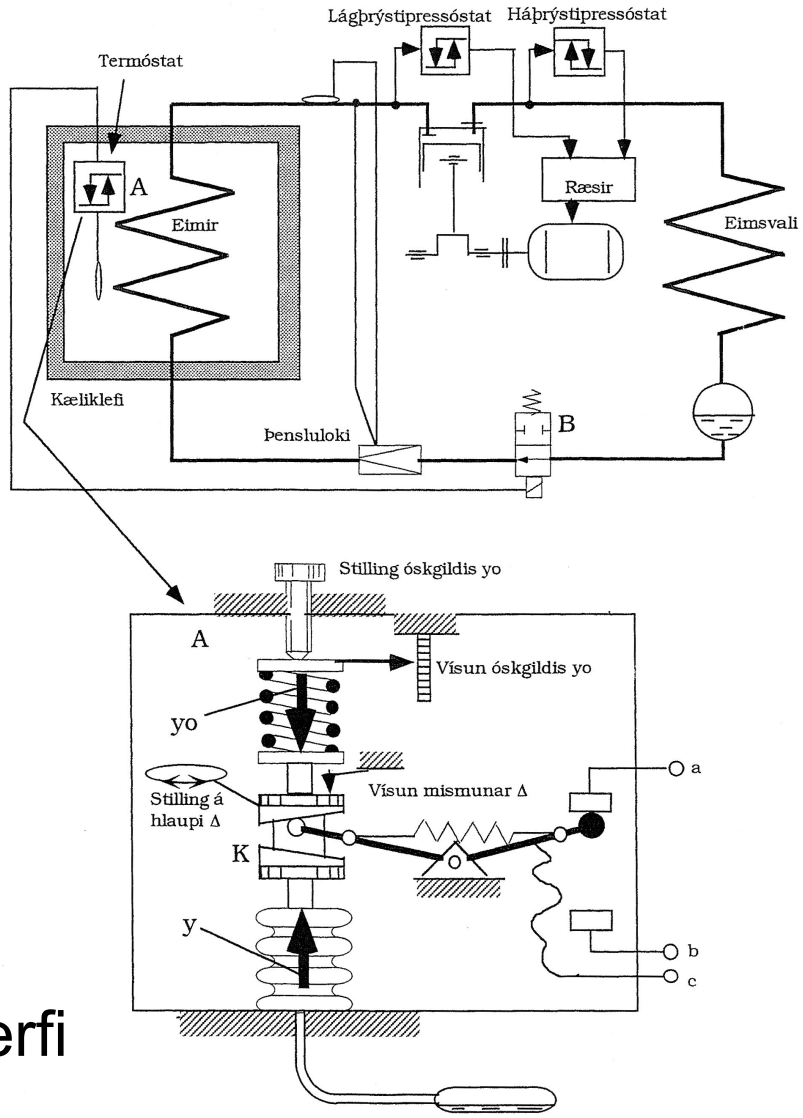
Kafli 4

Reglar

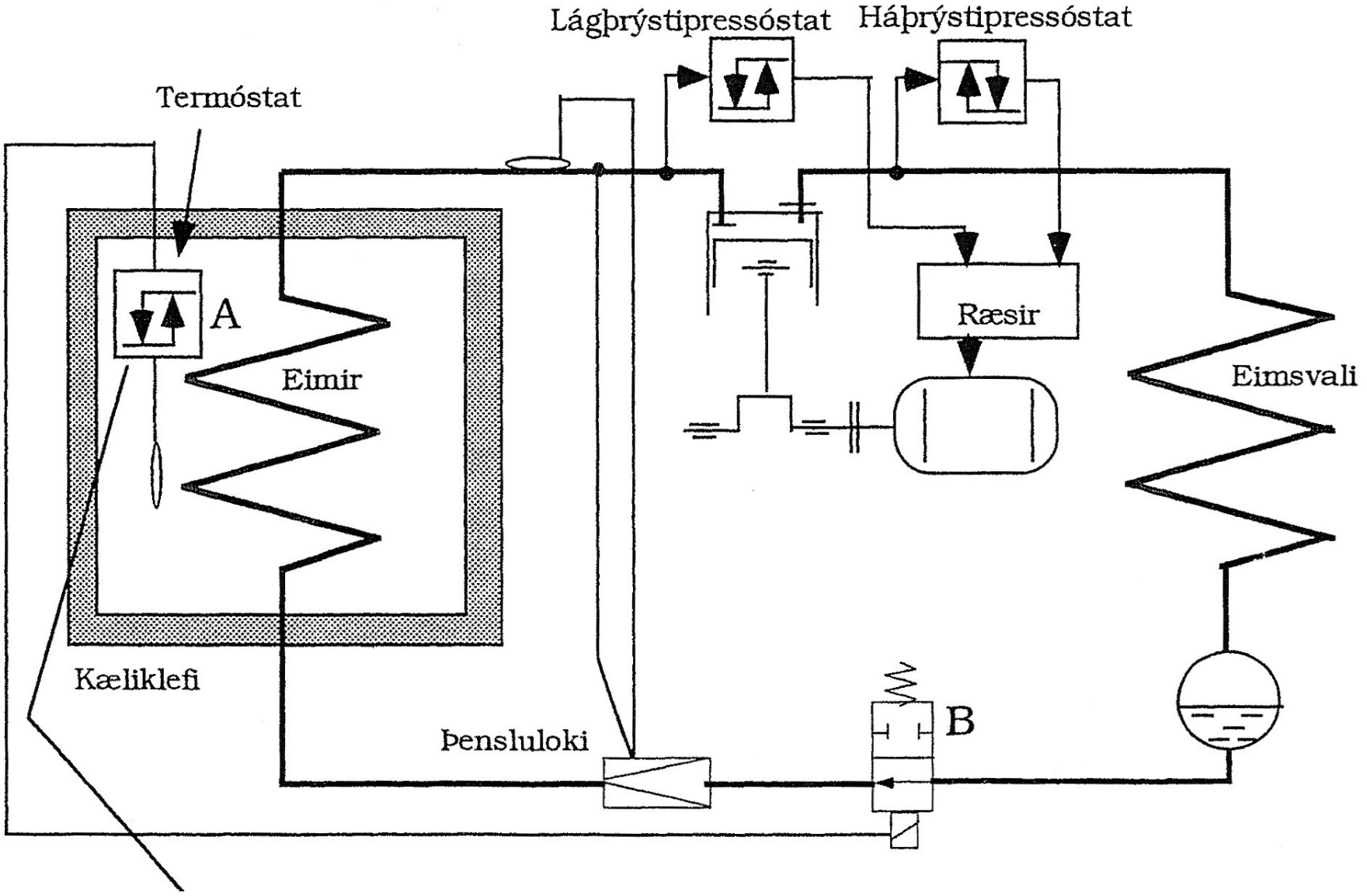

Reglunaraðferðir
Tvístöðureglun
(on - off regulating)
fjölstöðureglun
(continuos regulating)
T.d. pressóstat,
termóstat,
flotrofi.
P-reglun
PD-reglir
I-reglun
PI-reglir
D-reglun
PID-reglir
Loftorka
Vökvaorka
Raforka
Utanaðkomandi orka
nauðsynleg

Tvístöðureglar

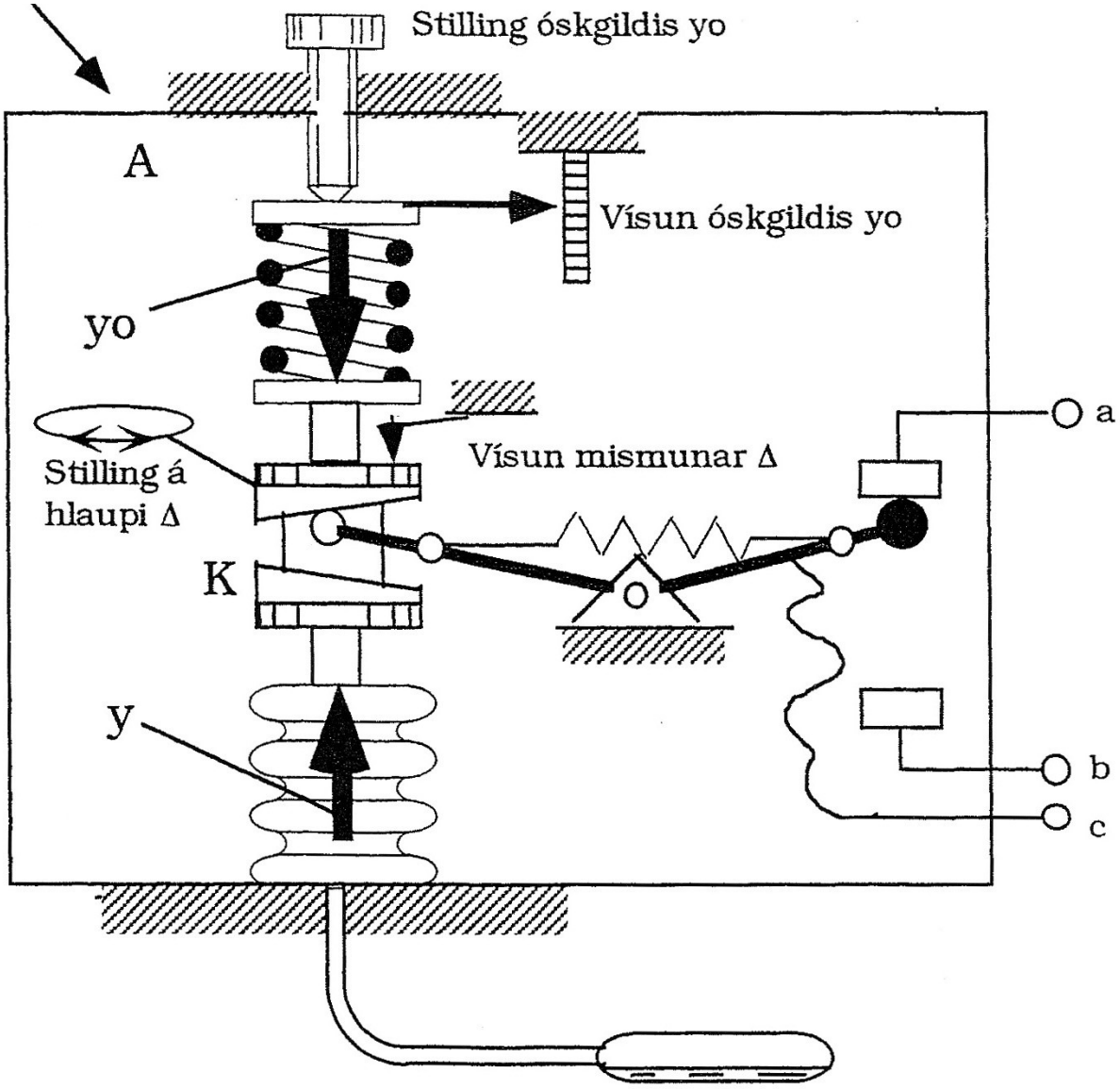
Tvístöðureglar eru algengir þar sem ekki er krafist mikillar nákvæmni.
Einfallt tvístöðu-reglunarkerfi var tekið fyrir í upphafi þessarar bókar á reglun hitastigs í herbergi.
Mynd 2.2



Kælikerfi

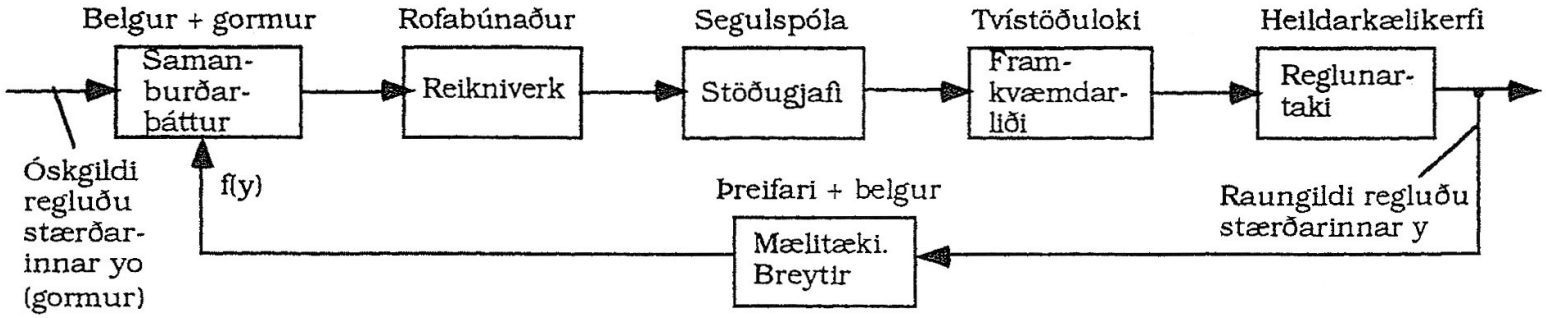

Lágþrýstipressóstat
Háþrýstipressóstat
Termóstat
A
Eimir
Ræsir
Eimsvali
Kæliklefi
Þensluloki
B

Hitareglir
(termostat)

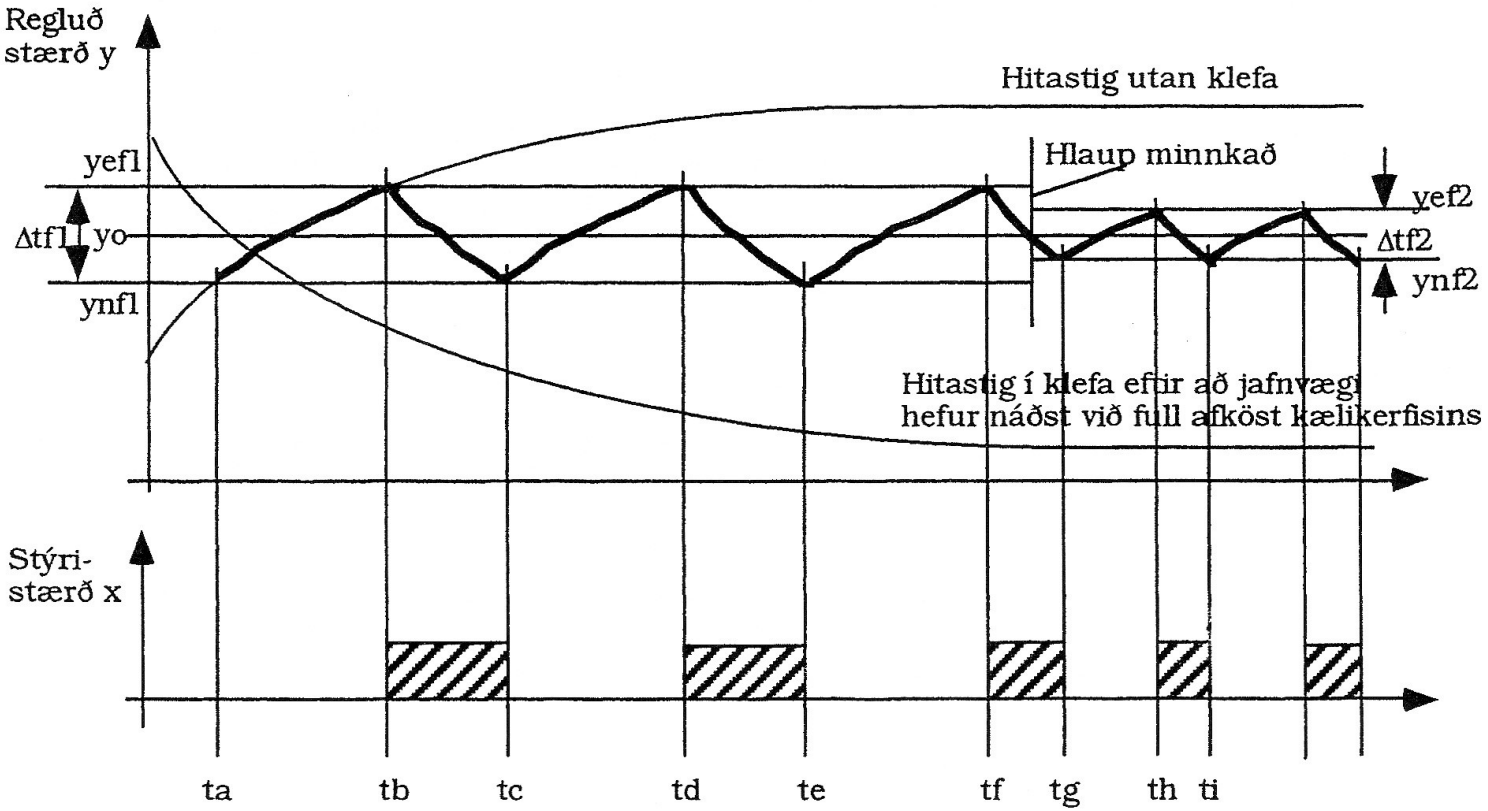


Blokkrit kælikerfis

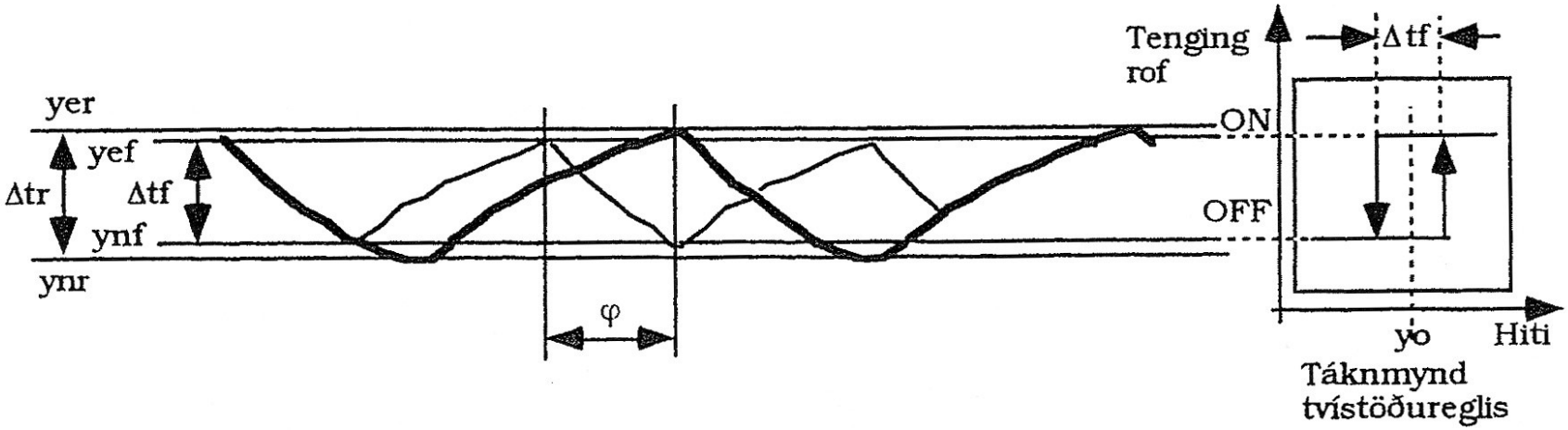
Í kæliklefanum er komið fyrir hitaregli (A) með eftifarandi hlutverk:
Að mæla hitastigið í kæliklefanum (raungildið), bera það saman við óskgildið og stjórna rafstýrða 2/2 lokanum (B) sem er stöðugjafi + framkvæmdaliði.



Kennilínur kælikerfisins og kæliklefans.



Tregða og dátími kælikerfisins



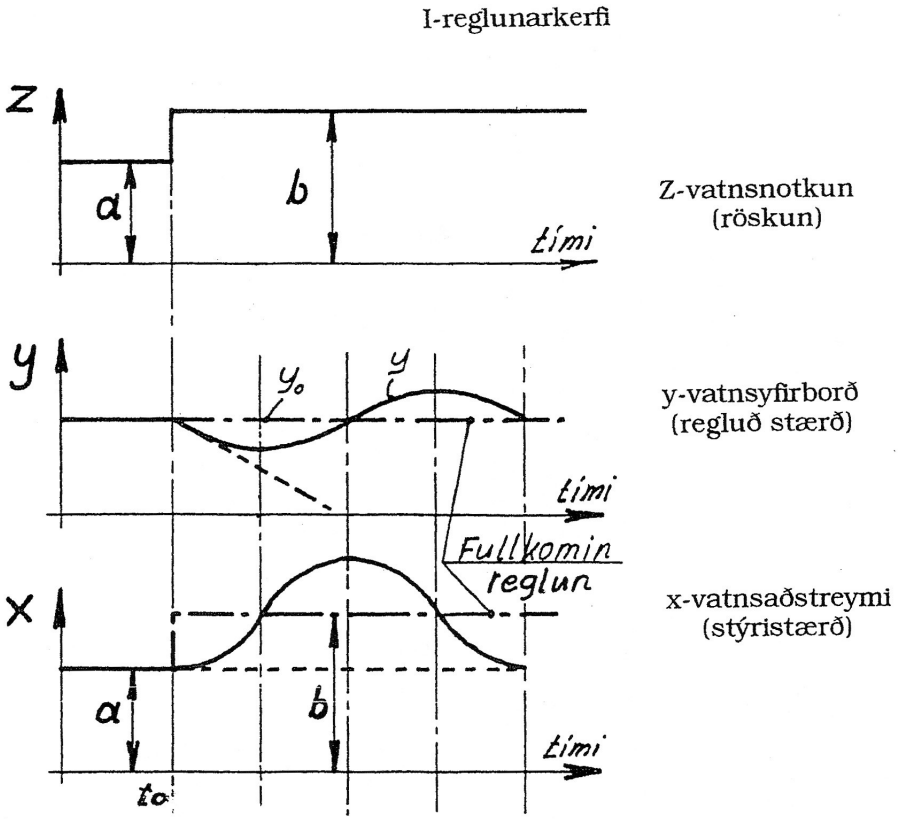
Fjölstöðurreglun

Sagan um
vatnsveitustjórann
og syni hans þrjá

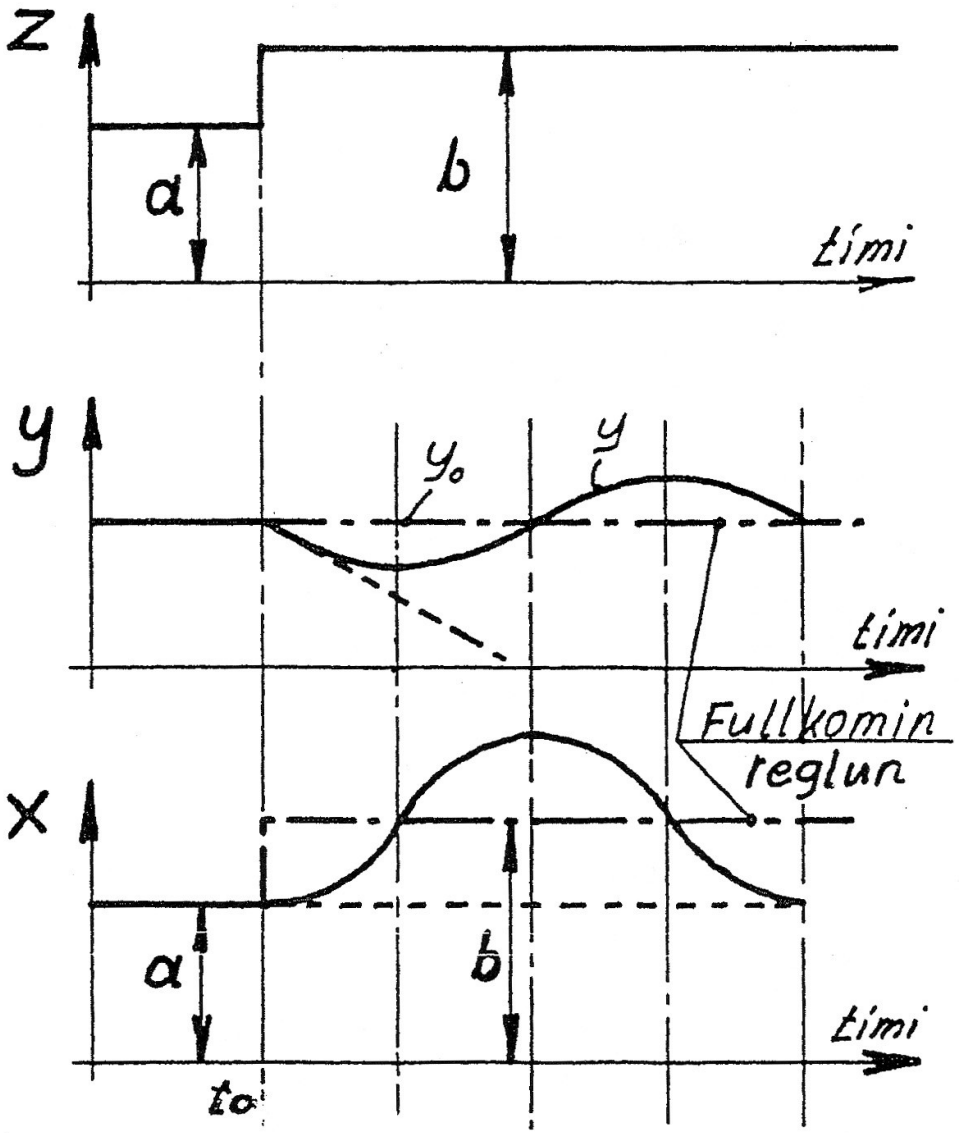
Ingvar / I-reglun

Opnunar- eða lokunarhraði lokans stóð í réttu hlutfalli við stærð fráviksins.

Rétt hlutfall er milli fráviksins frá óskgildi og hraðabreitingar stýrisstærðarinnar



I-reglunarkerfi



Z-vatnsnotkun
(röskun)

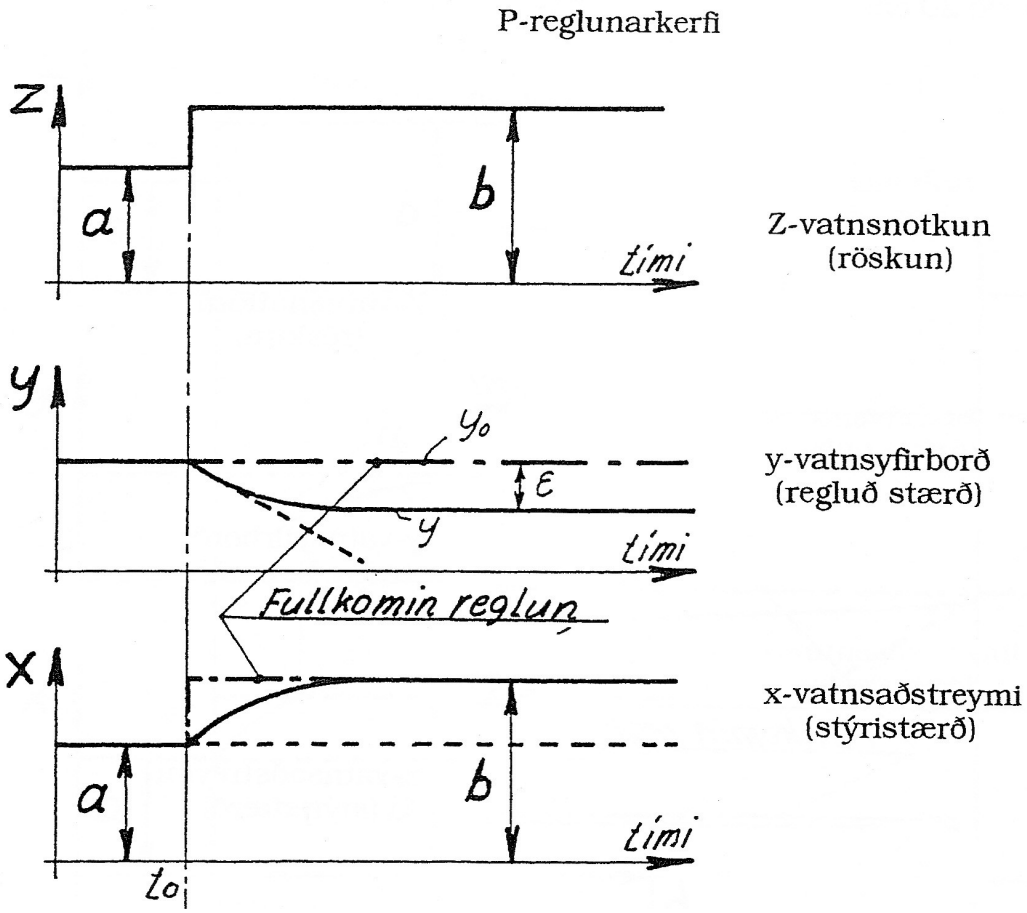
y-vatnsyfirborð
(regluð stærð)

x-vatnsaðstreymi
(stýristærð)

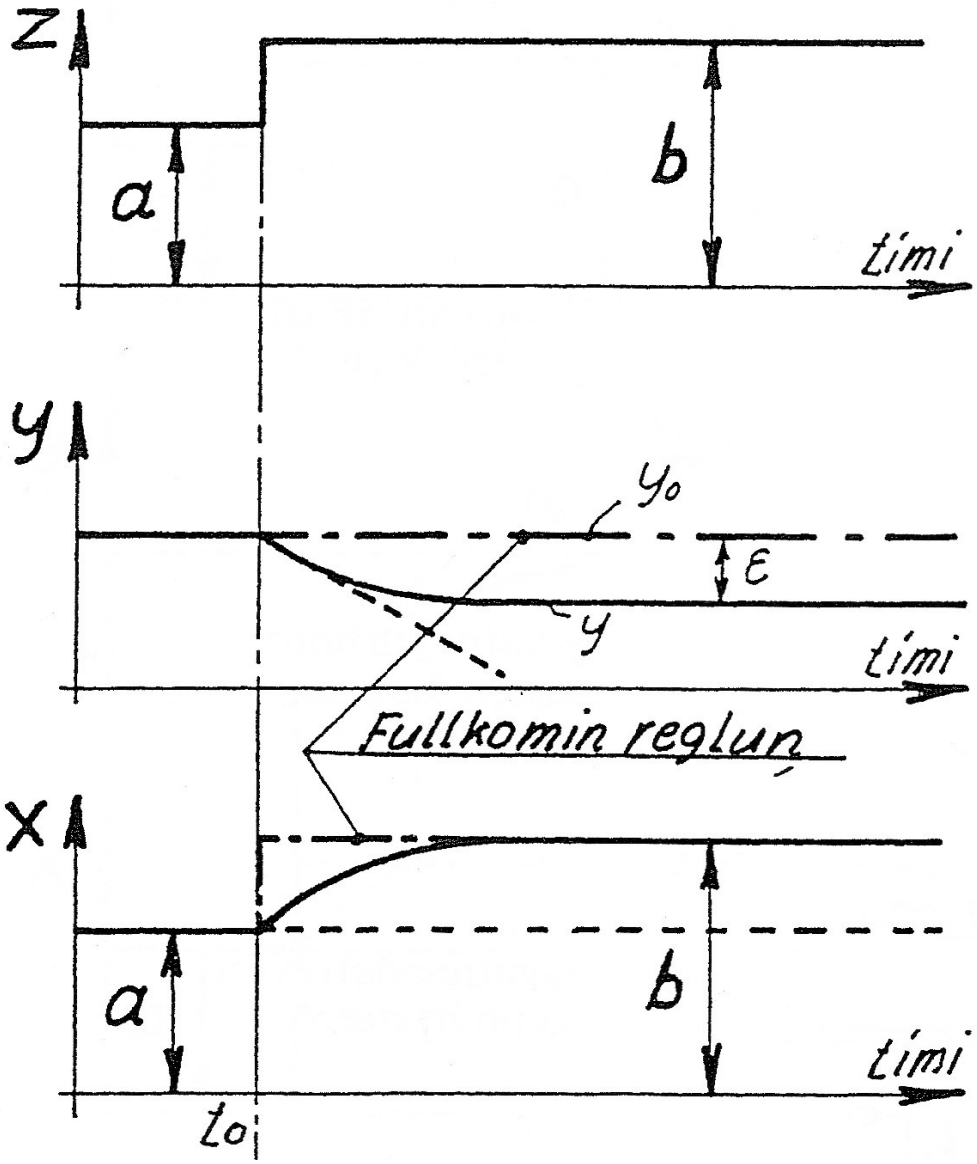
Pétur/P-reglun

Rétt hlutfal milli opunar lokans og fráviksins mill ósk- og raungildis vatnshæðarinnnar

Rétt hlutfall milli regluðu stærðarinnar og stýrisstærðarinnar.



P-reglunarkerfi

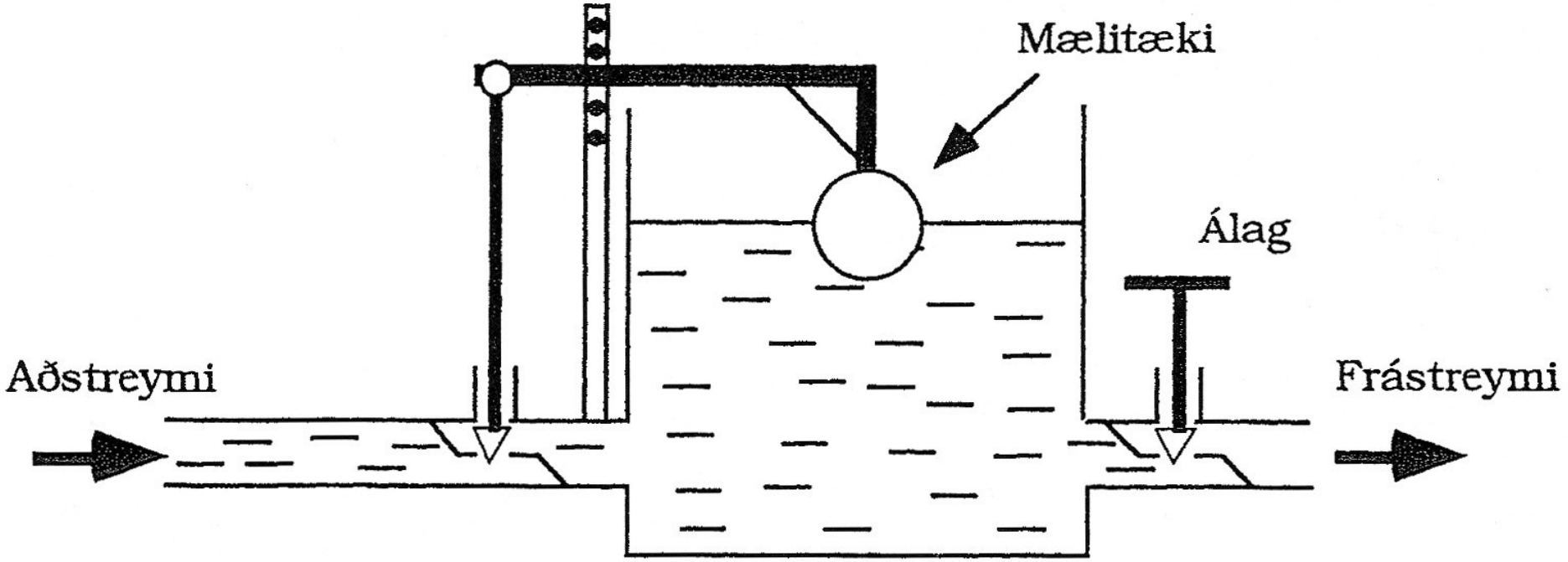


Z-vatnsnotkun
(röskun)

y-vatnsyfirborð
(regluð stærð)

x-vatnsaðstreymi
(stýristærð)

P-reglir

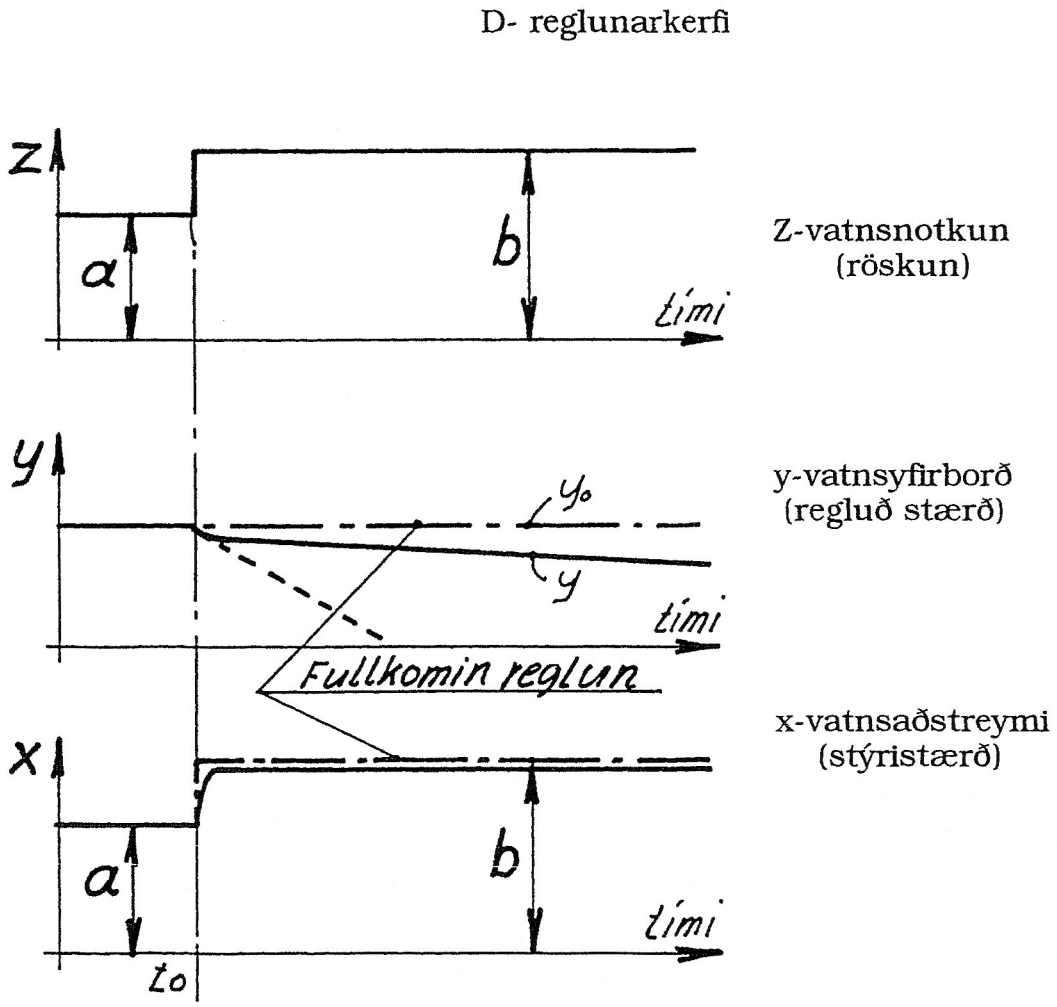


Rétt hlutfall er milli regluðu stærðarinnar og stýristærðarinnar.
Vatnshæðin helst óbreytt ef sama streymi er inn og út.

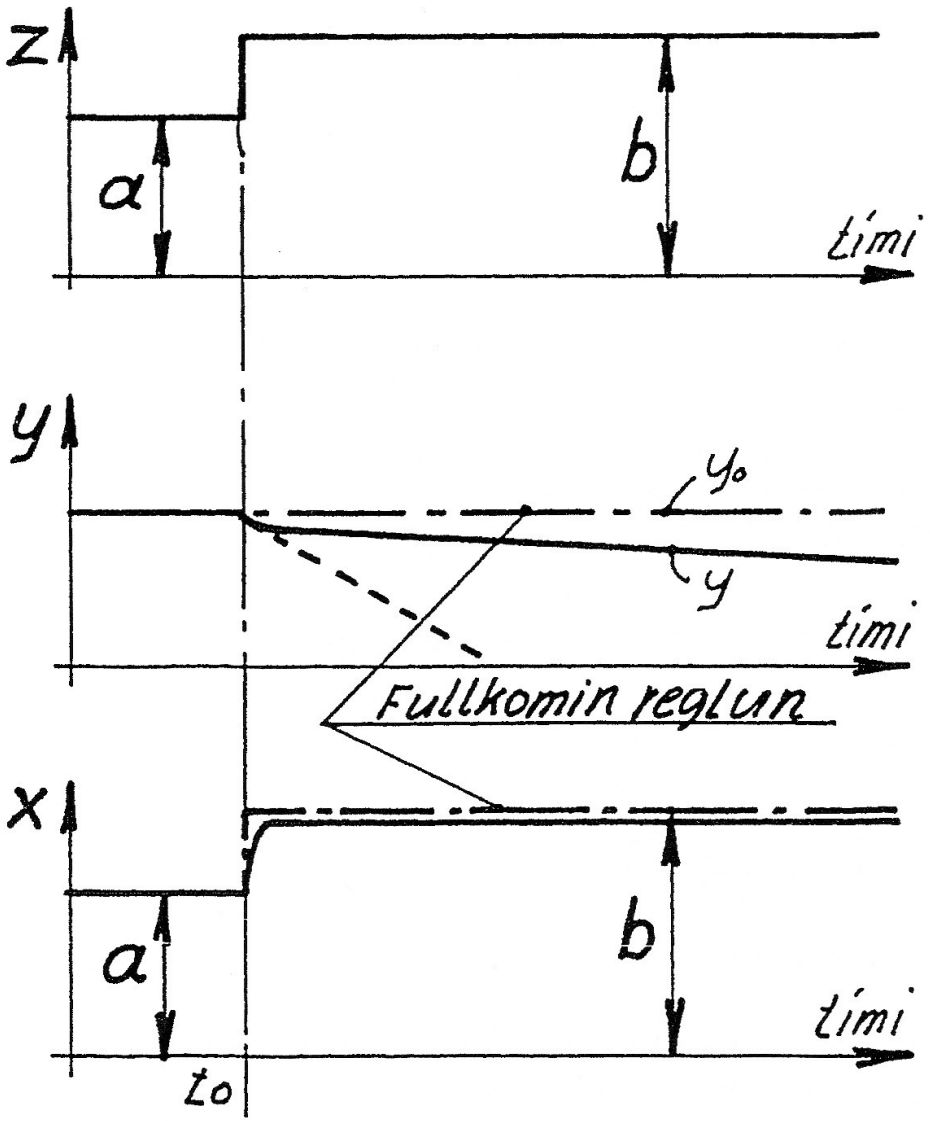
Davíð/D-reglun

Rétt hlufall á mill opnunar eða lokunar lokans og hraða breytingar vatnshæðarinnar.

Rétt hlutfall á milli stýristærðar og hraðans á breytingu regluðu stærðarinnar.



D- reglunarkerfi



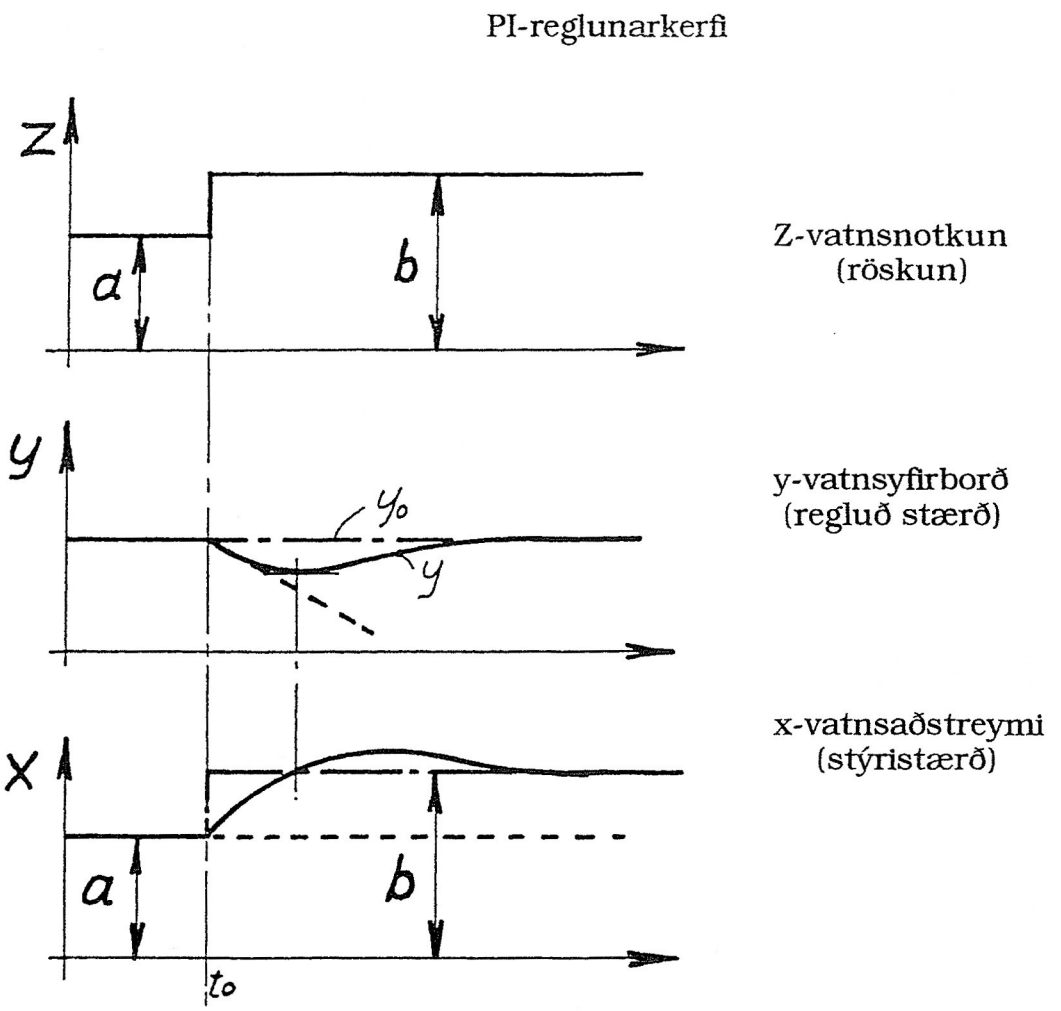
Z-vatnsnotkun
(röskun)

y-vatnsyfirborð
(regluð stærð)

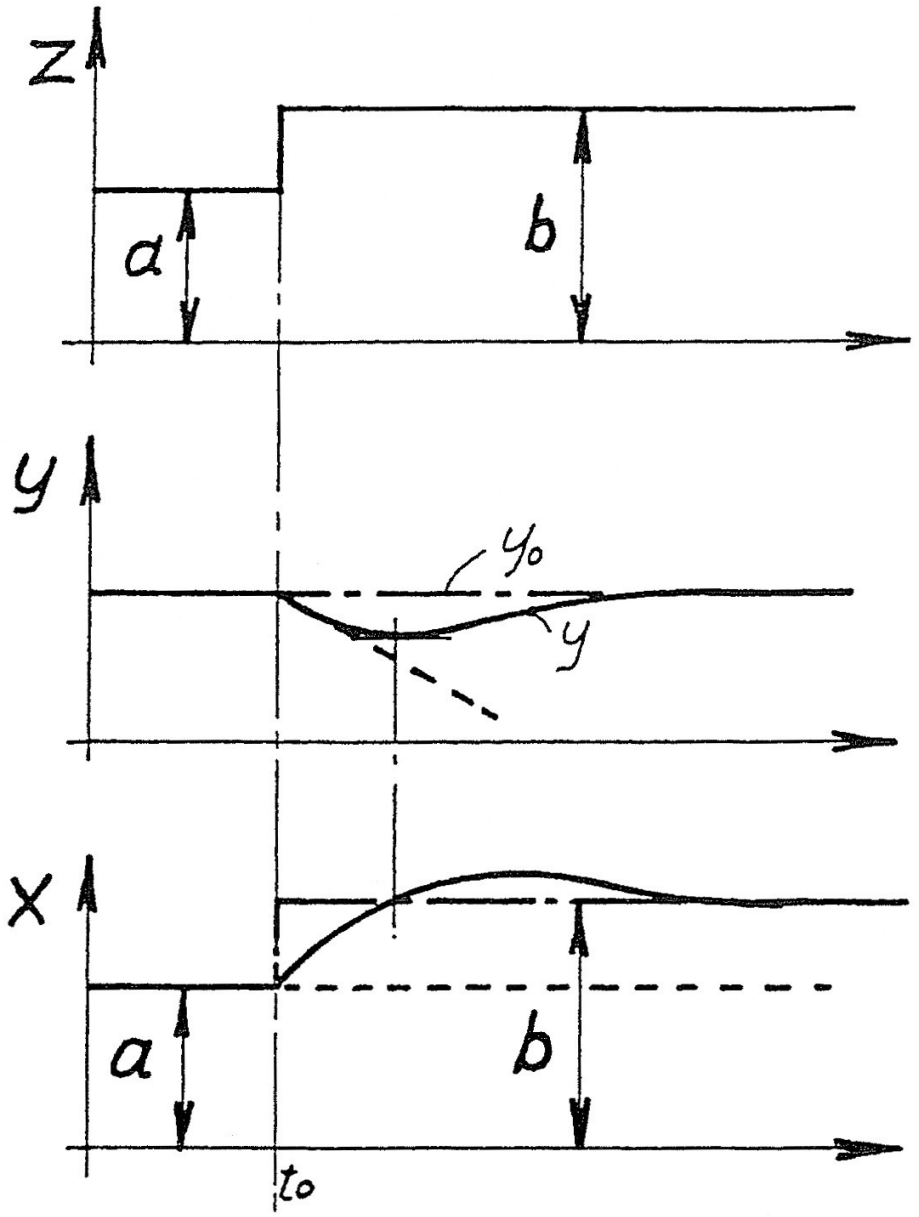
x-vatnsaðstreymi
(stýristærð)

Ingvar og Pétur/PI-reglir

Pétur stöðvar hæðar-breytinguna þar sem innú tústreyi er eins. Ingvar leiréttir skekkjun.



PI-reglunarkerfi



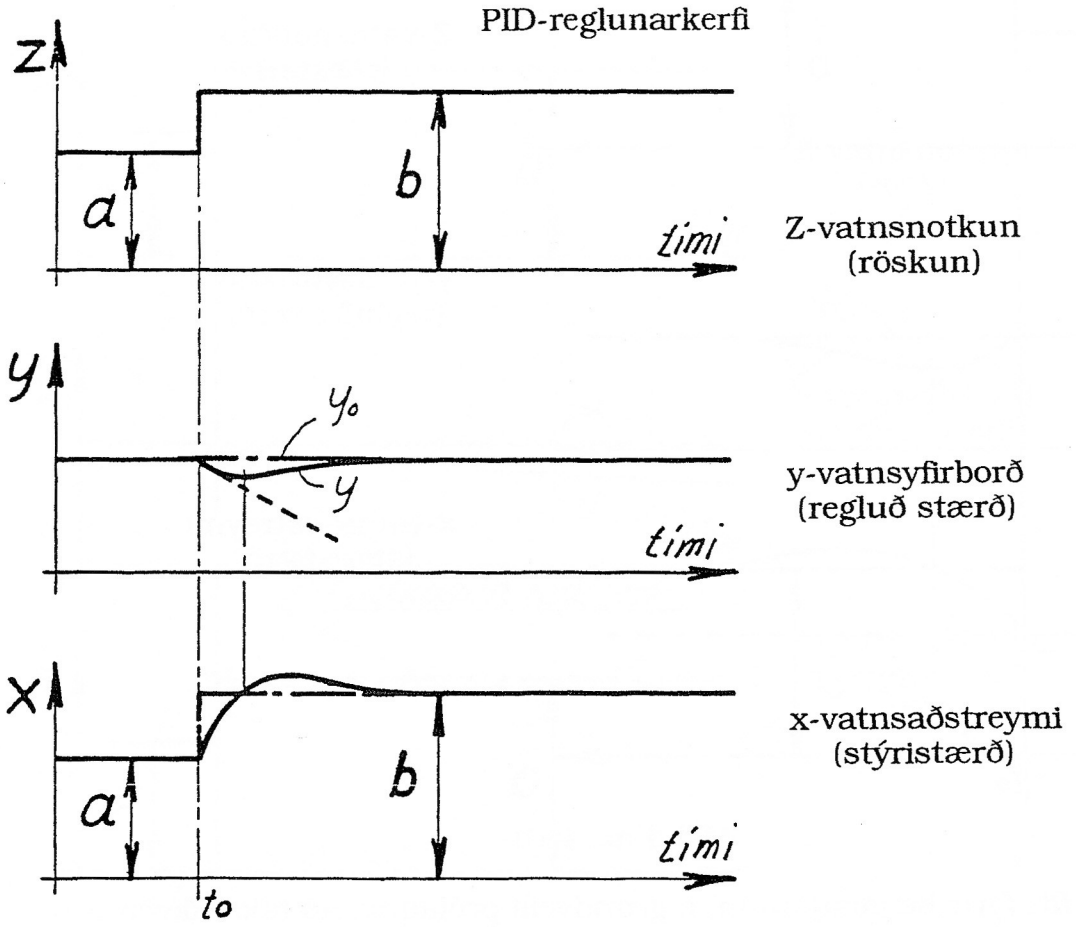
Z-vatnsnotkun
(röskun)

y-vatnsyfirborð
(regluð stærð)

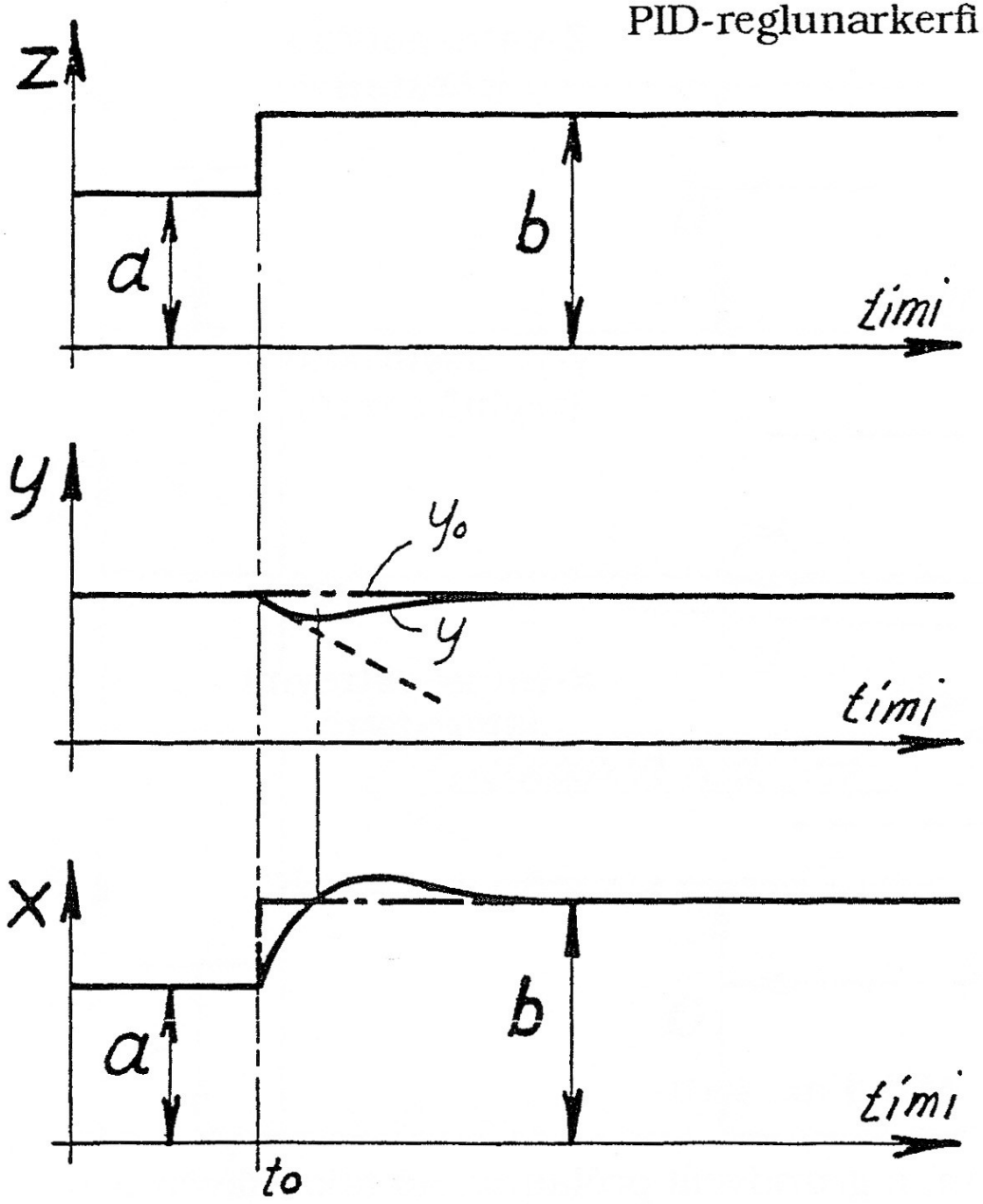
x-vatnsaðstreymi
(stýristærð)

Ingvar, Pétur og Davíð
PID-reglir

Davíð bregst við með tillit til hversu skekkjan vex hratt og minkar þannig hversu skekkjan verður mest.
Pétur stöðvar hæðar-breytinguna þar sem Inn og útstreymi er eins.
Ingvar leiréttir skekkjun.



PID-reglunarkerfi

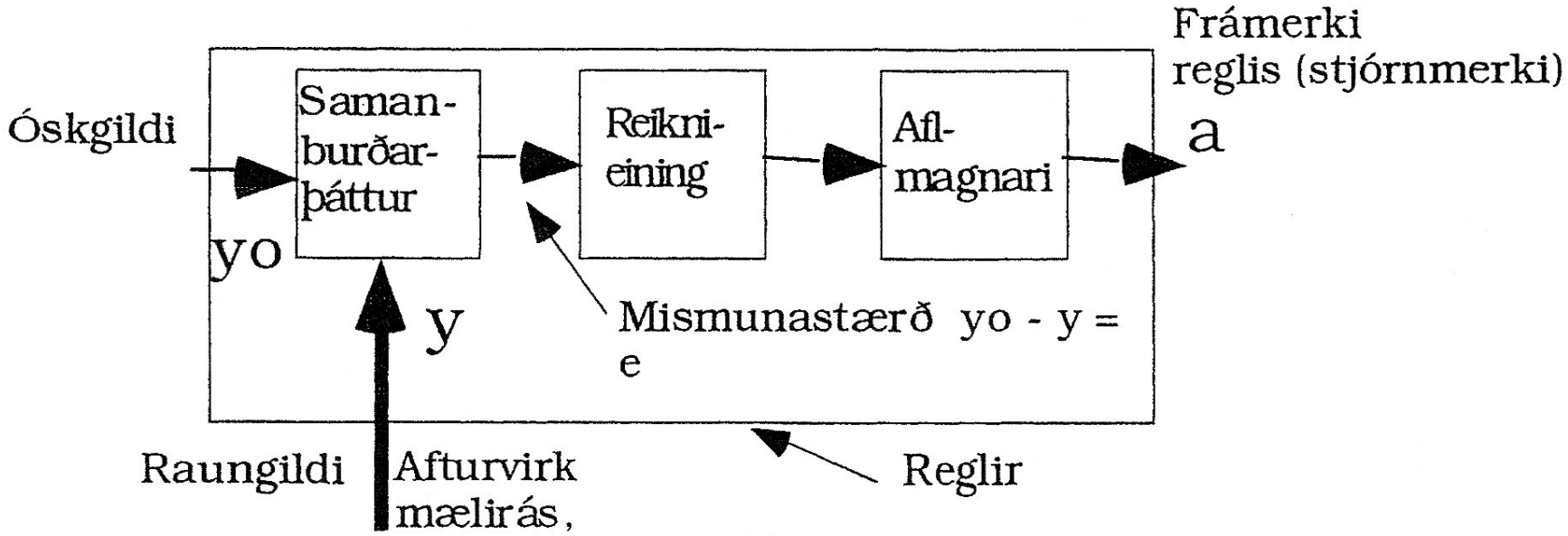


Z-vatnsnotkun
(röskun)

y-vatnsyfirborð
(regluð stærð)

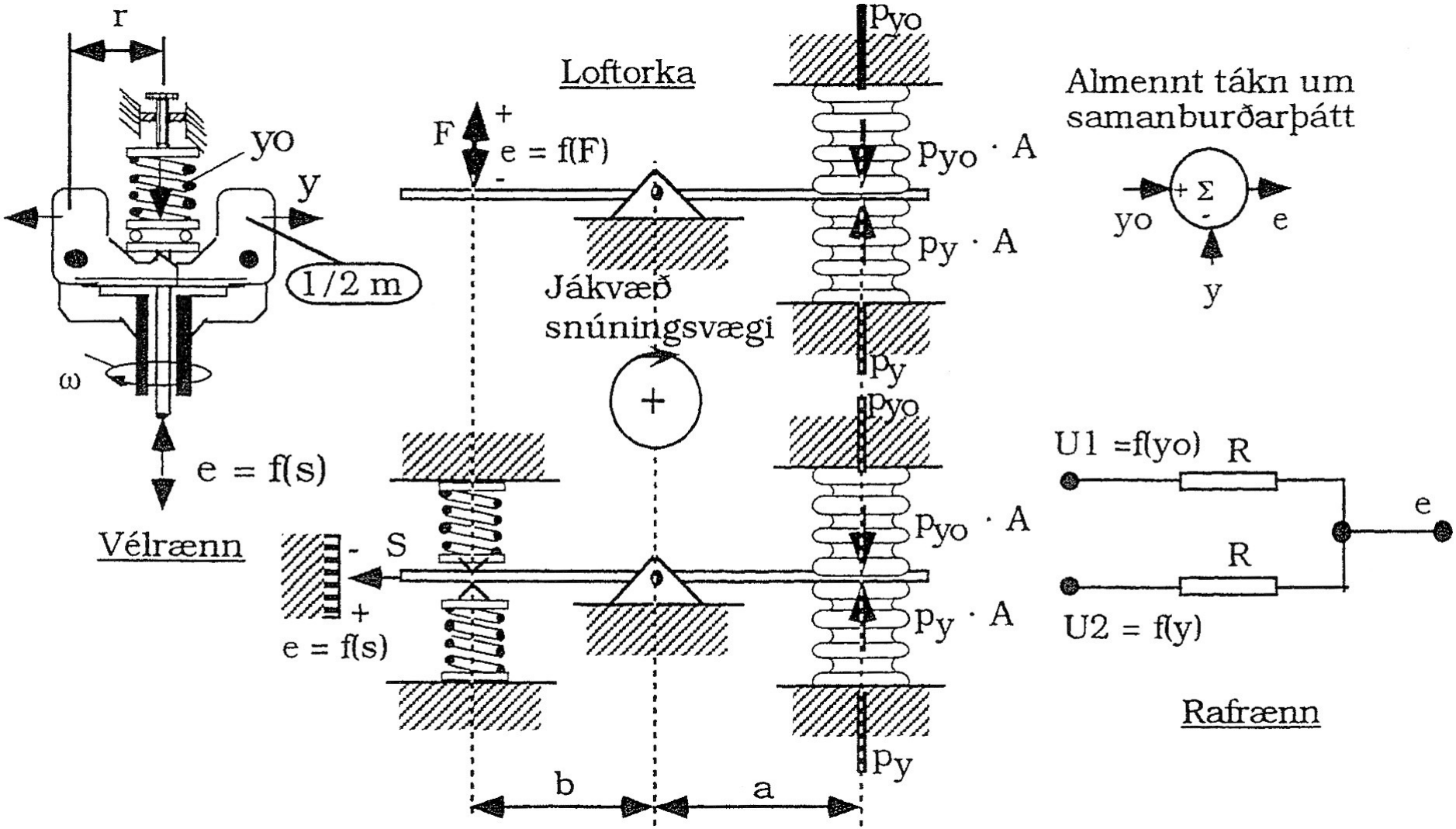
x-vatnsaðstreymi
(stýristærð)

Fjölstöðureglar

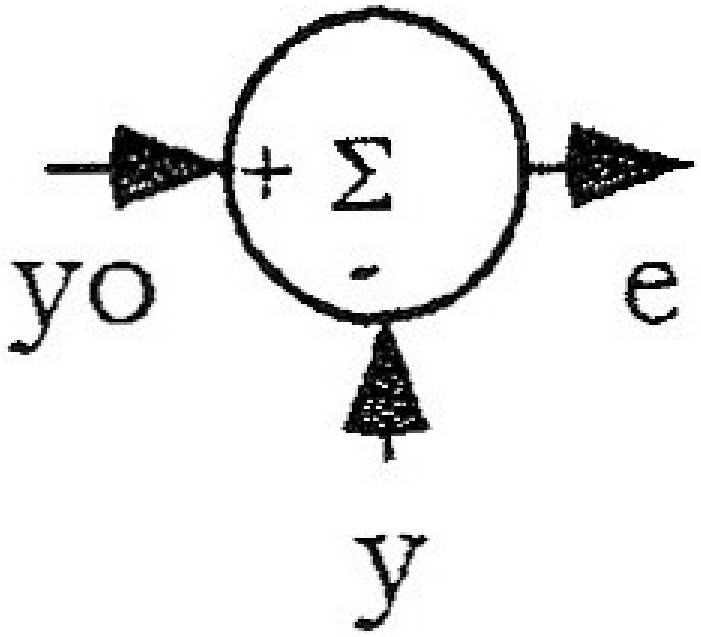


Samanburðarþáttur

- Innstærðir samanburðarþáttarins eru tvær. Það er óskgildi (kjörgildi) yo og mælt raungildi regluðustærðarinnar y.
- Mismunur þessara merkja kallast mismunastærð, sem er frámerki samanburðarþáttarins og er táknað með bókstafnum e.
- Hlutverk samanburðarþáttarins er að framkvæma fyrrnefndan samanburð á sjálvikran hátt.


r
yo
y
1/2 m
ω
e = f(s)
Vélrænn
Loftorka
F
+
e = f(F)
-
Jákvæð
snúningsvægi
+
- S
+
e = f(s)
Pyo
Pyo · A
Py · A
Py
Pyo
Pyo · A
Py · A
Py
b
a
Almennt tákn um
samanburðarþátt
yo
+ Σ
-
e
y
U1 =f(yo)
R
e
R
U2 = f(y)
Rafrænn

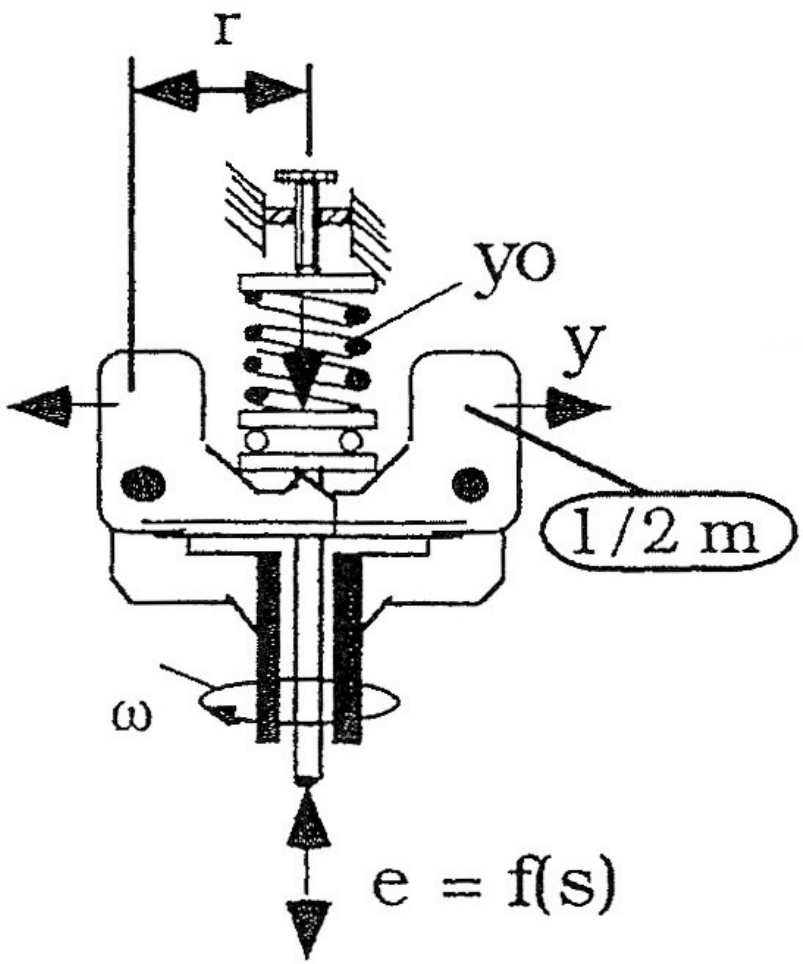
Almennt tákn um samanburðarþátt



$$F = m \cdot r \cdot \omega^2 = k \cdot s^2$$

eða

$$s = \sqrt{\frac{m \cdot r}{k}} \cdot \omega$$

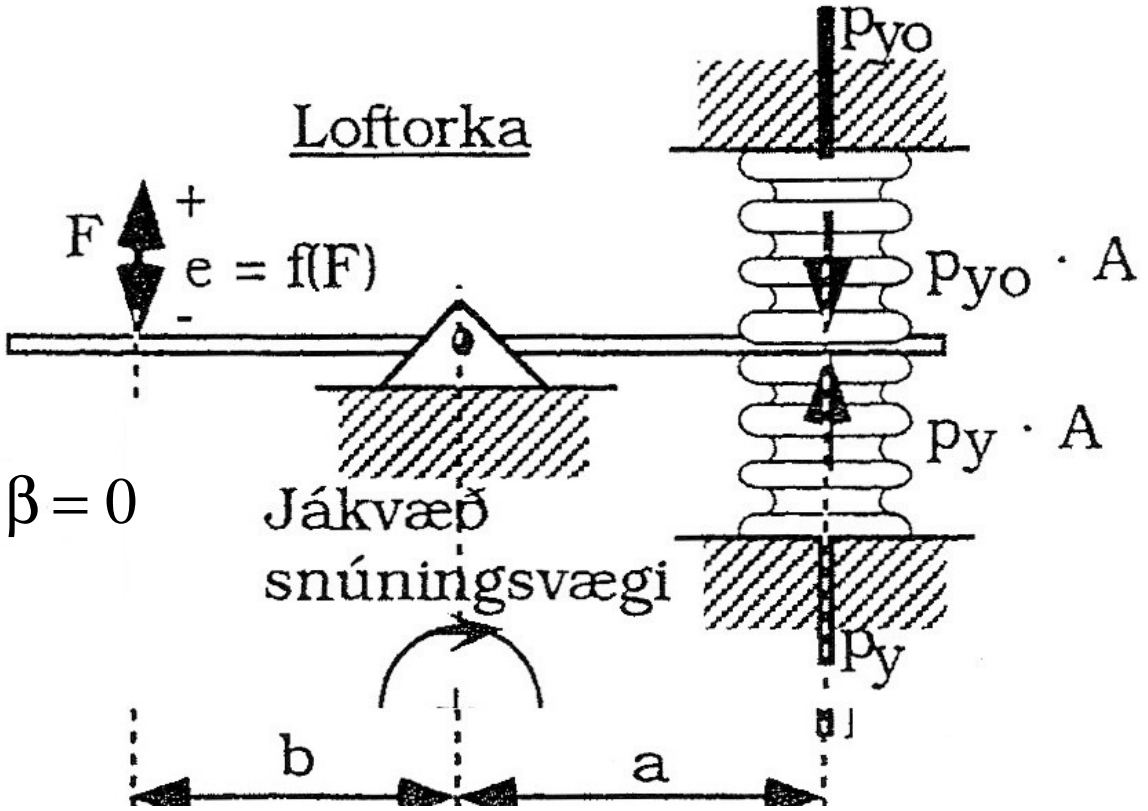


Vélrænn

Kraftajafnvægi loftmerkja

$$p_{yo} \cdot A \cdot \alpha - \pi_{\psi} \cdot A \cdot \alpha + \Phi \cdot \beta = 0$$

$$\Phi = -\frac{\alpha}{\beta} \cdot A \cdot (\pi_{\psi o} - \pi_{\psi})$$

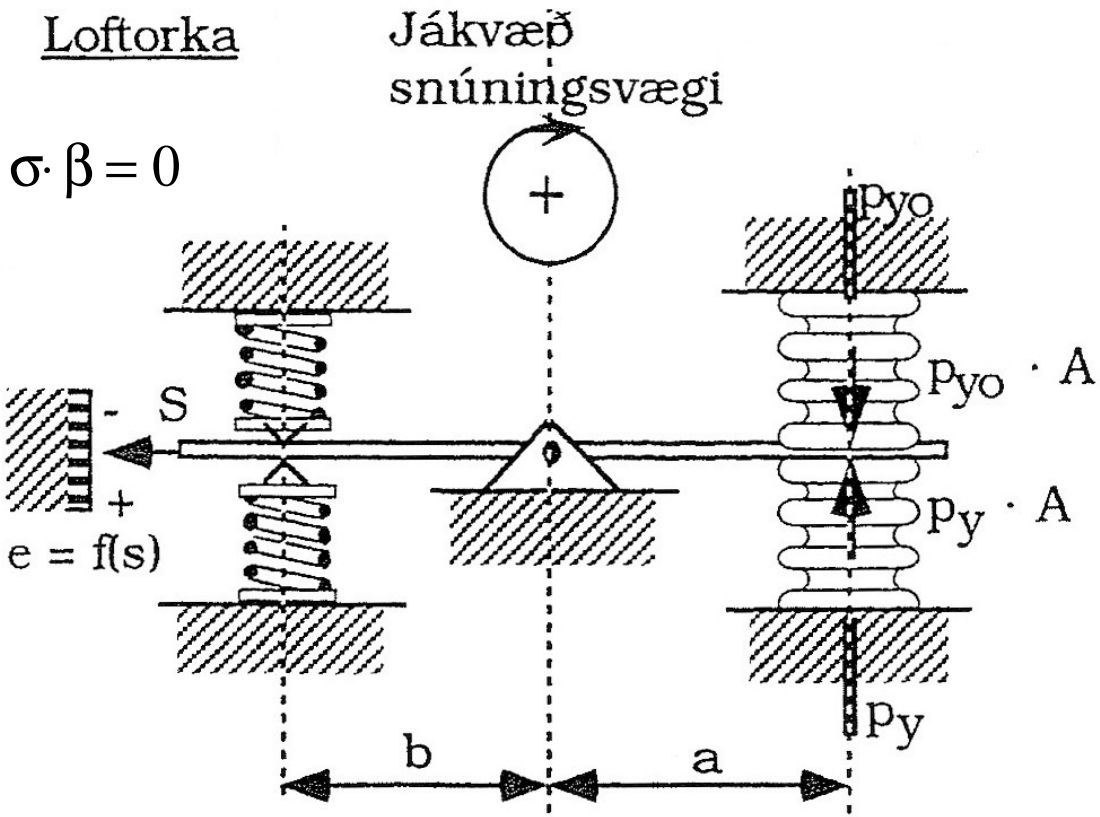


Hreyfijafnvægi loftmerkja

$$p_{yo} \cdot A \cdot \alpha - \pi_{\psi} \cdot A \cdot \alpha + \kappa_{\gamma} \cdot \sigma \cdot \beta = 0$$

$$\sigma = -\frac{\alpha}{\beta \cdot \kappa_{\gamma}} \cdot A \cdot (\pi_{\psi o} - \pi_{\psi})$$

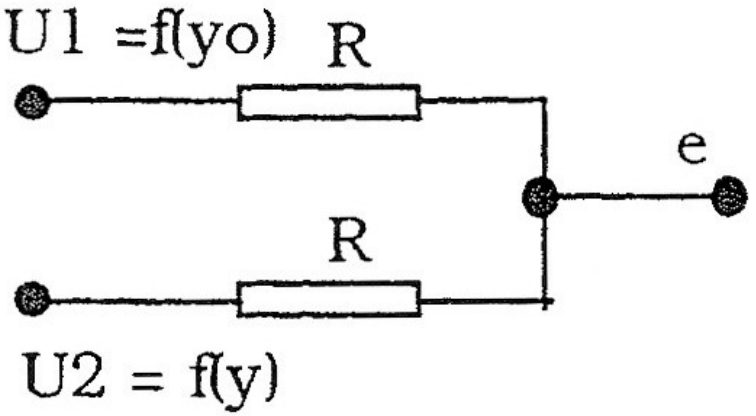
$$\kappa_{\gamma} = \frac{\Delta \Phi}{\Delta \sigma}$$



Rafrænn samanburðarþáttur

$$\frac{U_1 - \varepsilon}{P} = \frac{\varepsilon - Y_2}{P}$$

$$\varepsilon = \frac{Y_1 + Y_2}{2}$$



Rafrænn

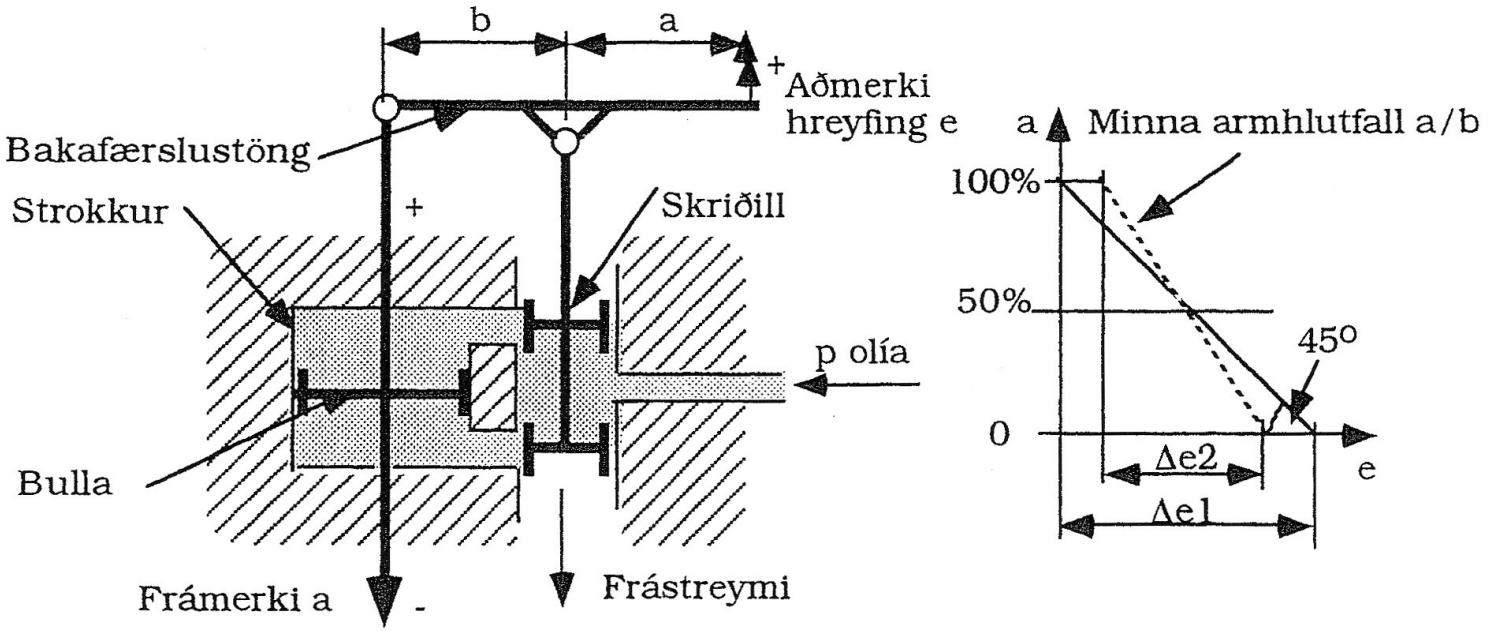
Reiknieining

- Hjarta reiknieingarinnar er aðgerðarmagnarinn.
- Eins og áður hefur komið fram er merkið frá samanburðarþættinum veikt og er hlutverk aðgerðarmagnarans að taka við þessu merki og gefa því þann styrk sem reiknieiningunni er nauðsynlegur til að meðhöndla það og gefa því það form sem óskað er eftir.

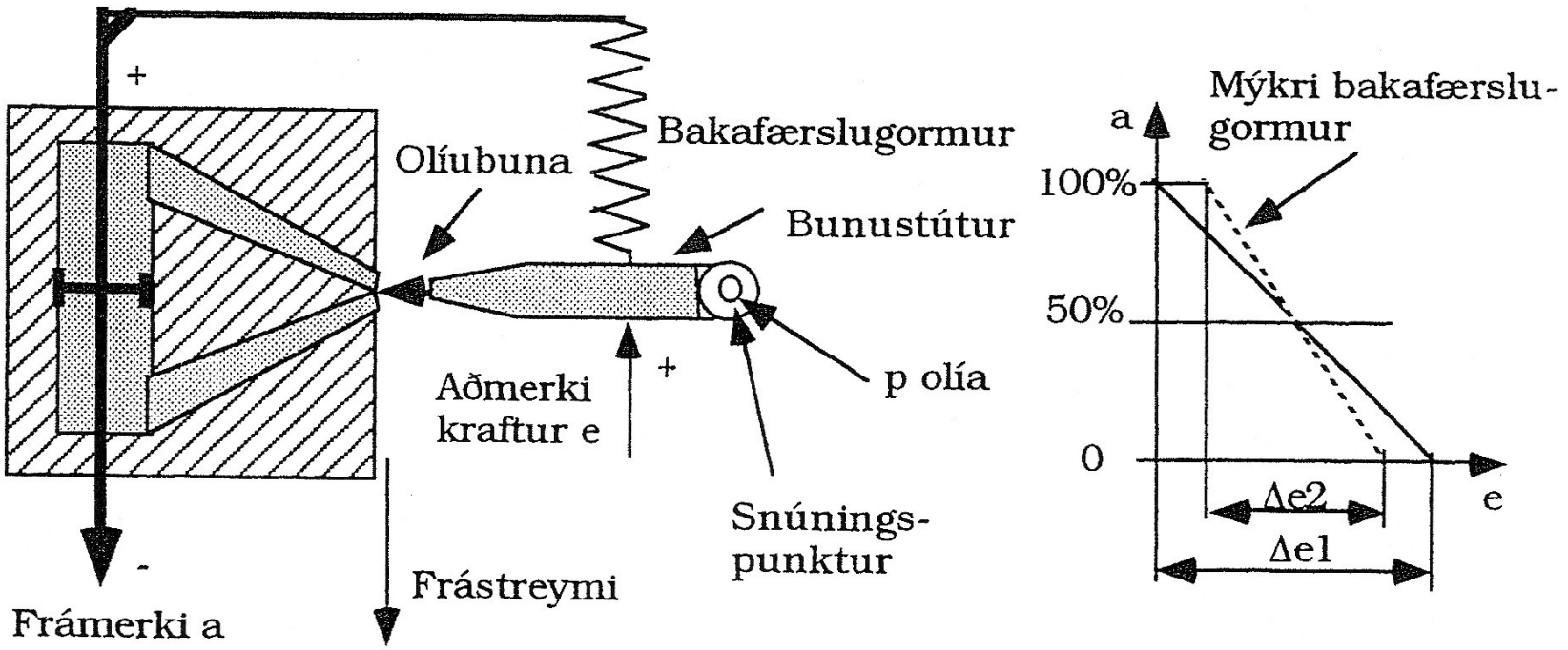
Bakafærsla

- Hugtakið bakafærsla kemur nú fyrst fyrir og tengist það aðgerðamögnurunum.
- Bakafærsla er nýtt til þess að stýra aðgerðamagnaranum og gefa honum æskilega eiginleika eins og nánar verður komið inn á þegar eiginleikar reiknieininga verður teknir fyrir.
- Sé aðgerðarmagnari án bakafærslu starfar hann við það mikla mögnun að útmerki hans er annaðhvort 0% eða 100%.
- Í þeim dæmum sem hér eru tekin fyrir er viðkomandi aðgerðarmagnari með bakafærslu til að hægt sé að stjórna mögnunni.

Aðgerðamagnarar í vélrænum þrýstivökvareglum

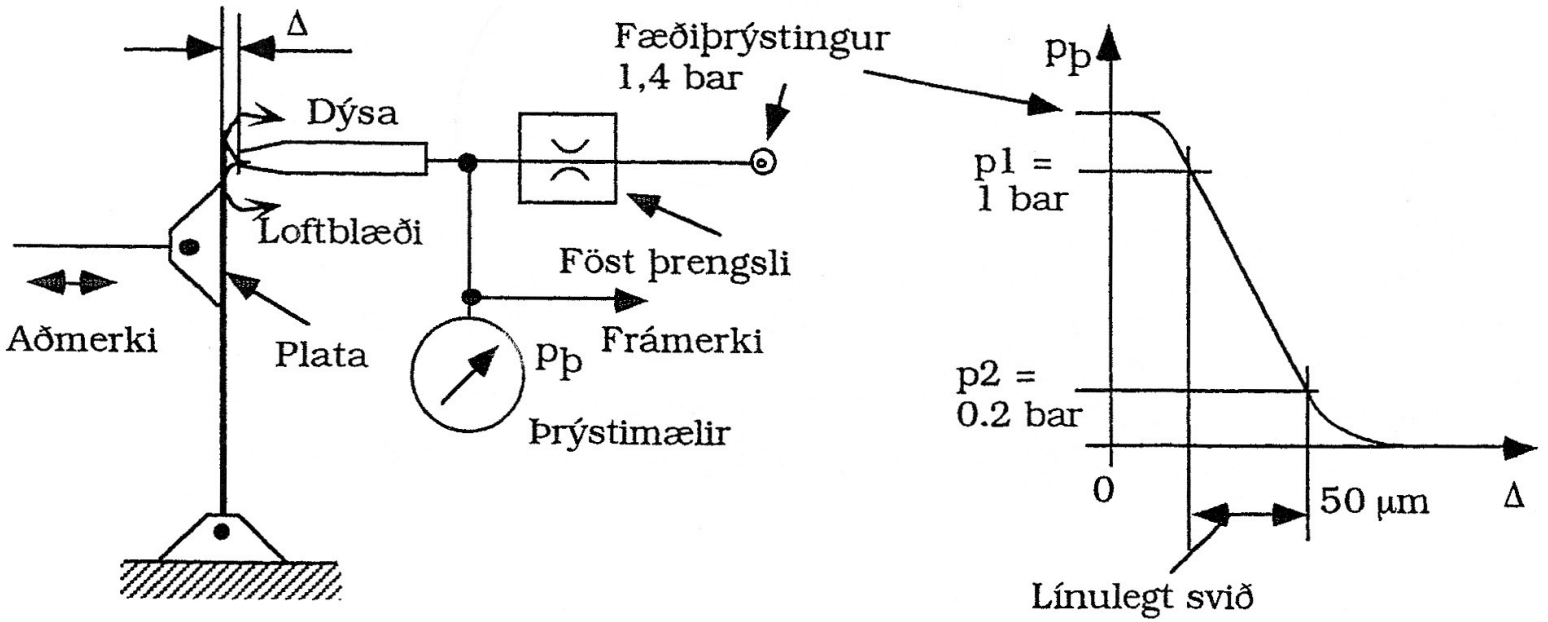


Skriðilmagnari



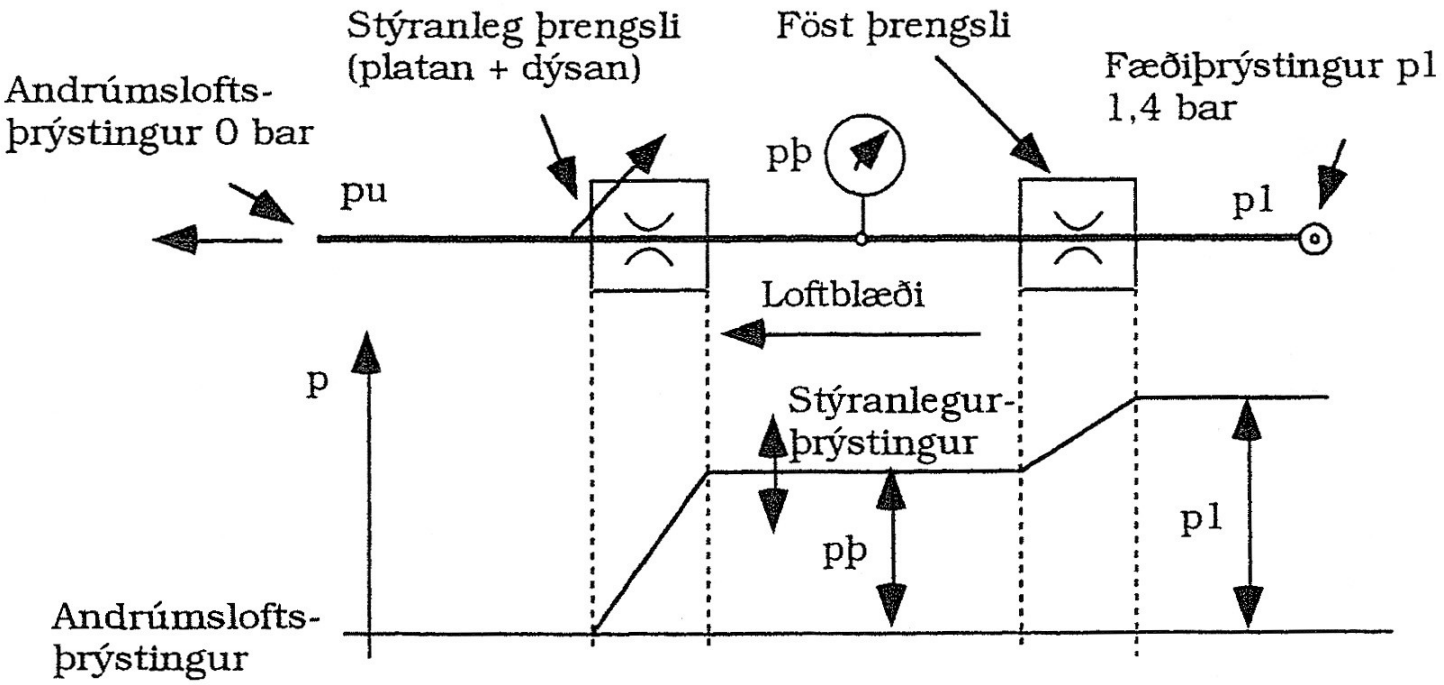
Bunustútsmagnari

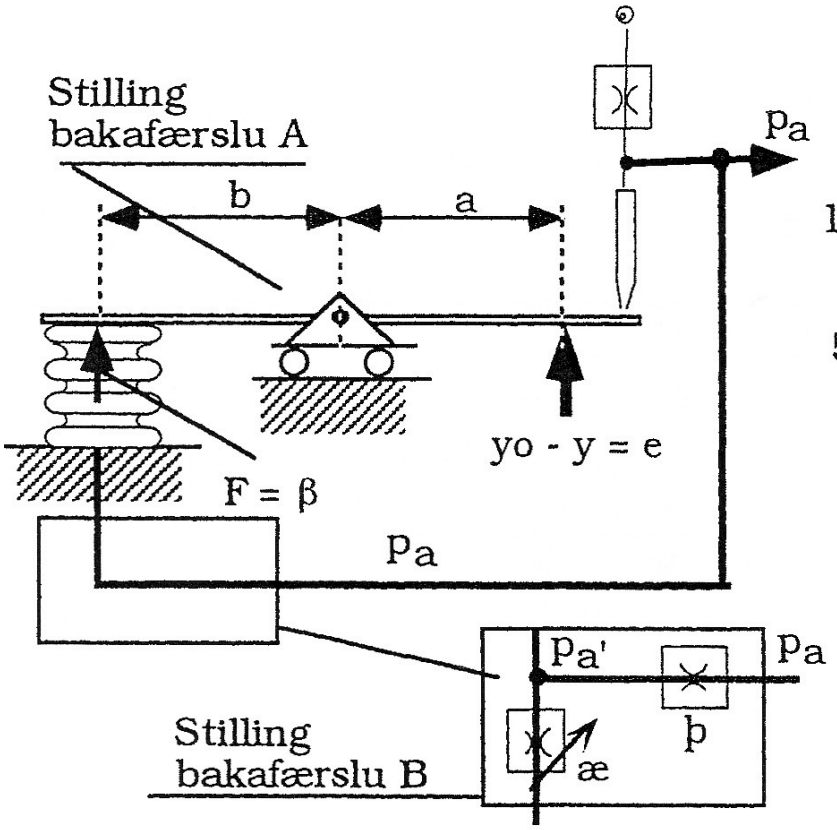
Aðgerðamagnarar í reglum sem nota loftorku

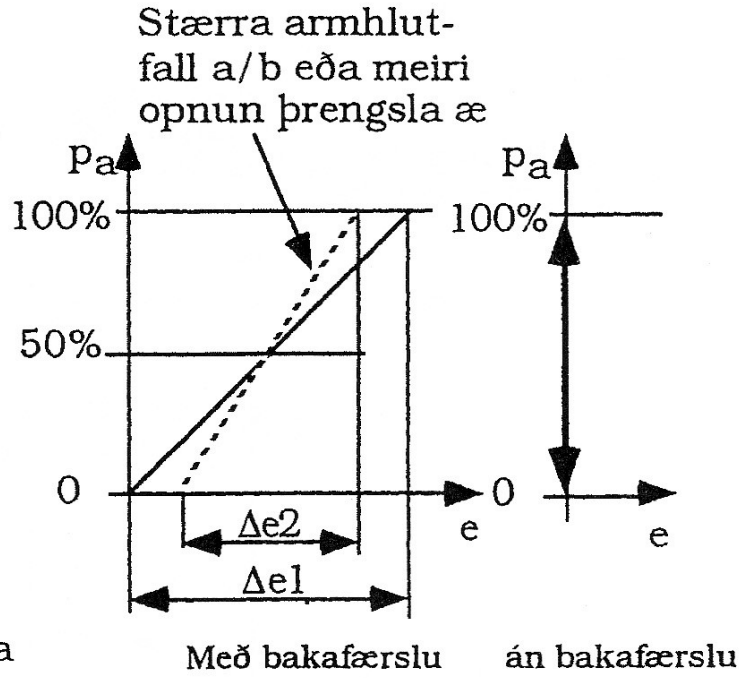


Plötu-dýsu magnari

Þrepun


Stýranleg þrengsli
(platan + dýsan)
Föst þrengsli
Fæðiþrýstingur p1
1,4 bar
Andrúmslofts-
þrýstingur 0 bar
pu
pþ
p1
Loftblæði
p
Stýranlegur-
þrýstingur
pþ
p1
Andrúmslofts-
þrýstingur

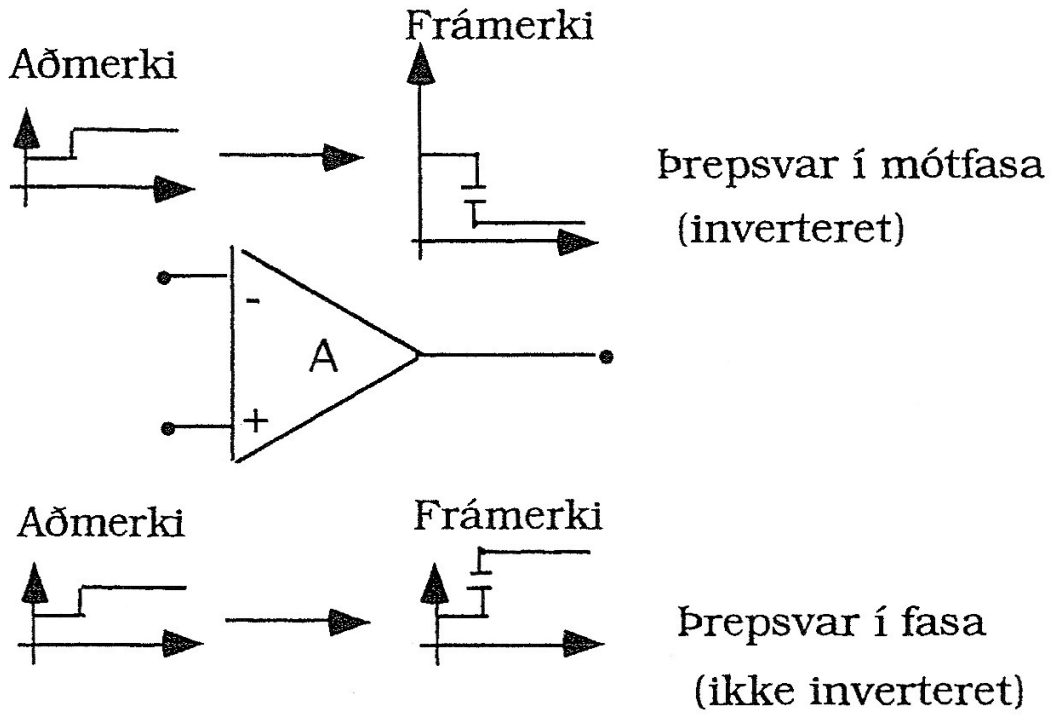


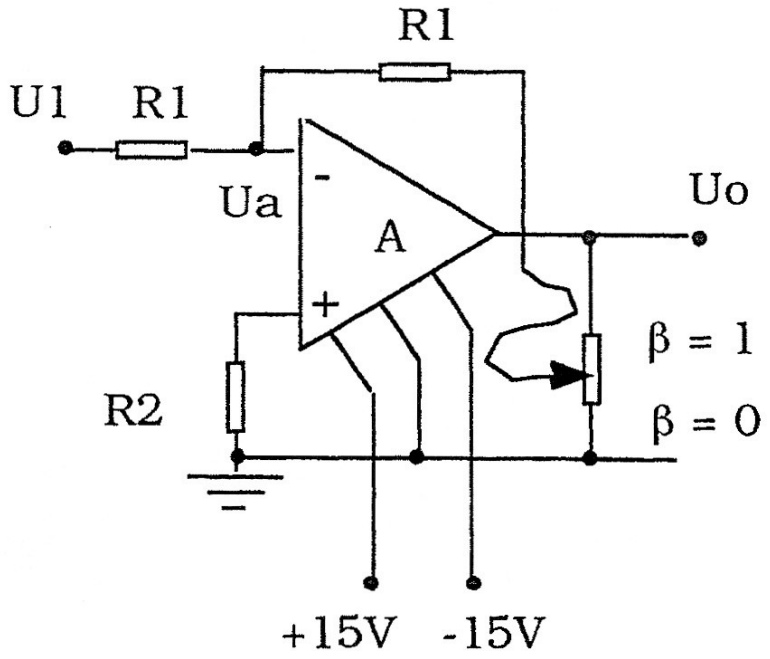


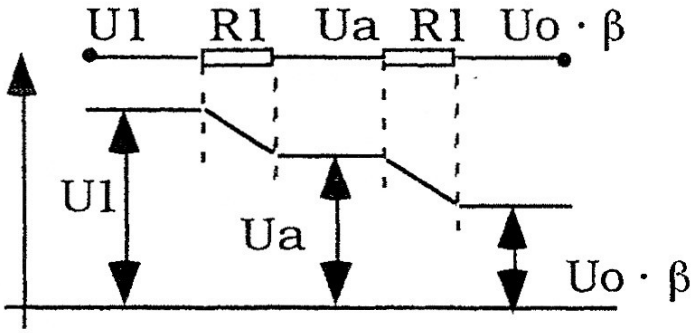
$$-e \cdot a + p_a \cdot A \cdot b = 0; \quad p_a = \frac{a}{b \cdot A} \cdot e$$

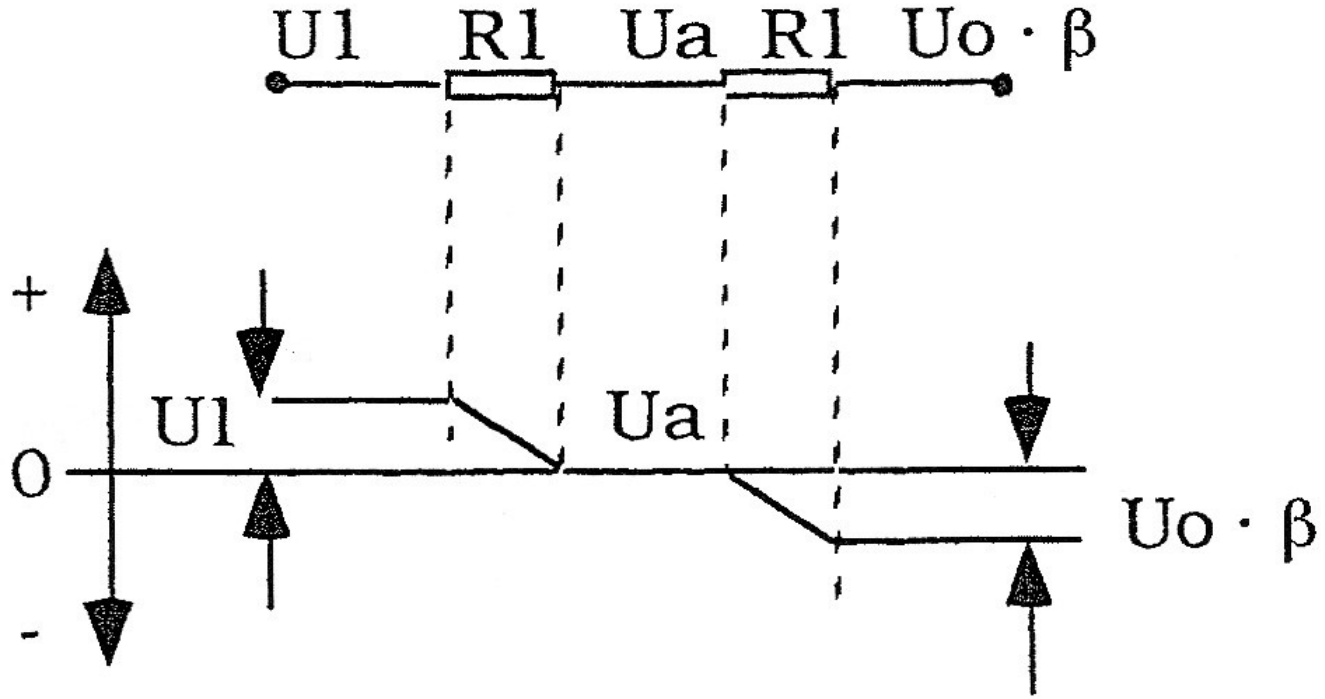
$$K = \frac{\Delta p_a}{\Delta e} = \frac{a}{b \cdot A}$$

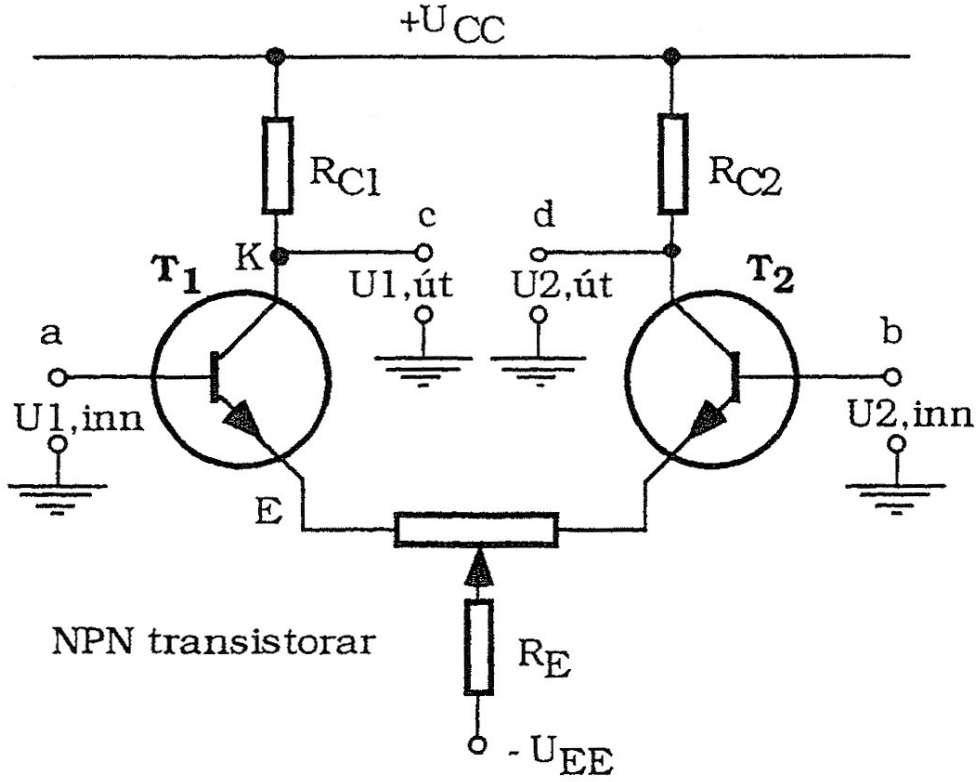
Aðgerðamagnarar í reglum sem nota raforku

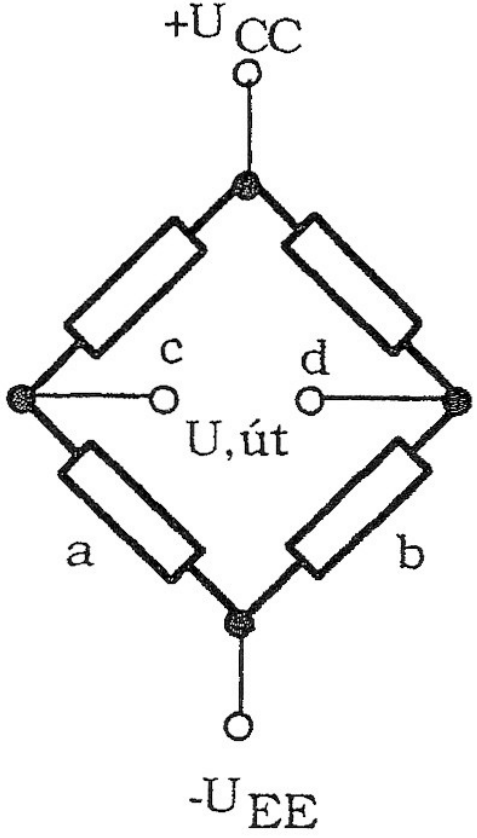



R1
U1
R1
Ua
-
A
+
Uo
β = 1
β = 0
R2
+15V
-15V

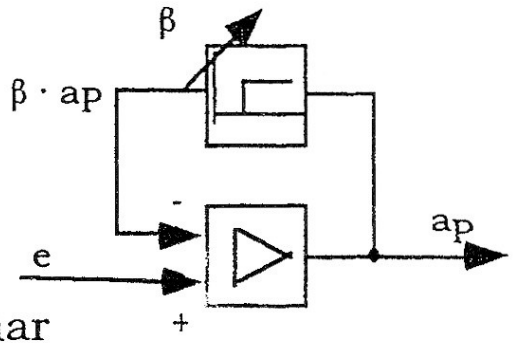
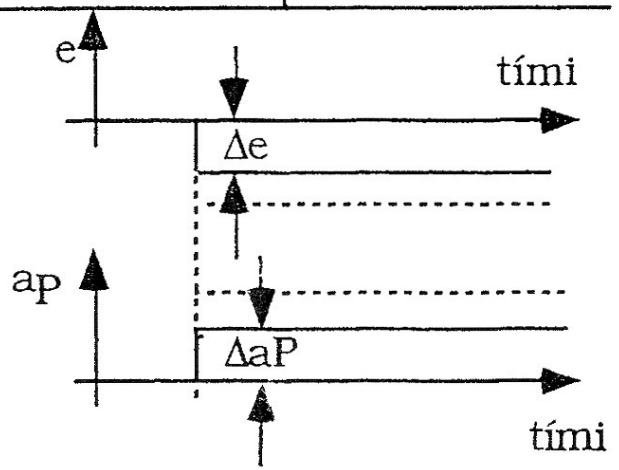

U1
R1
Ua
R1
Uo · β
U1
Ua
Uo · β


U1
R1
Ua
R1
Uo · β
+
U1
Ua
0
Uo · β
-

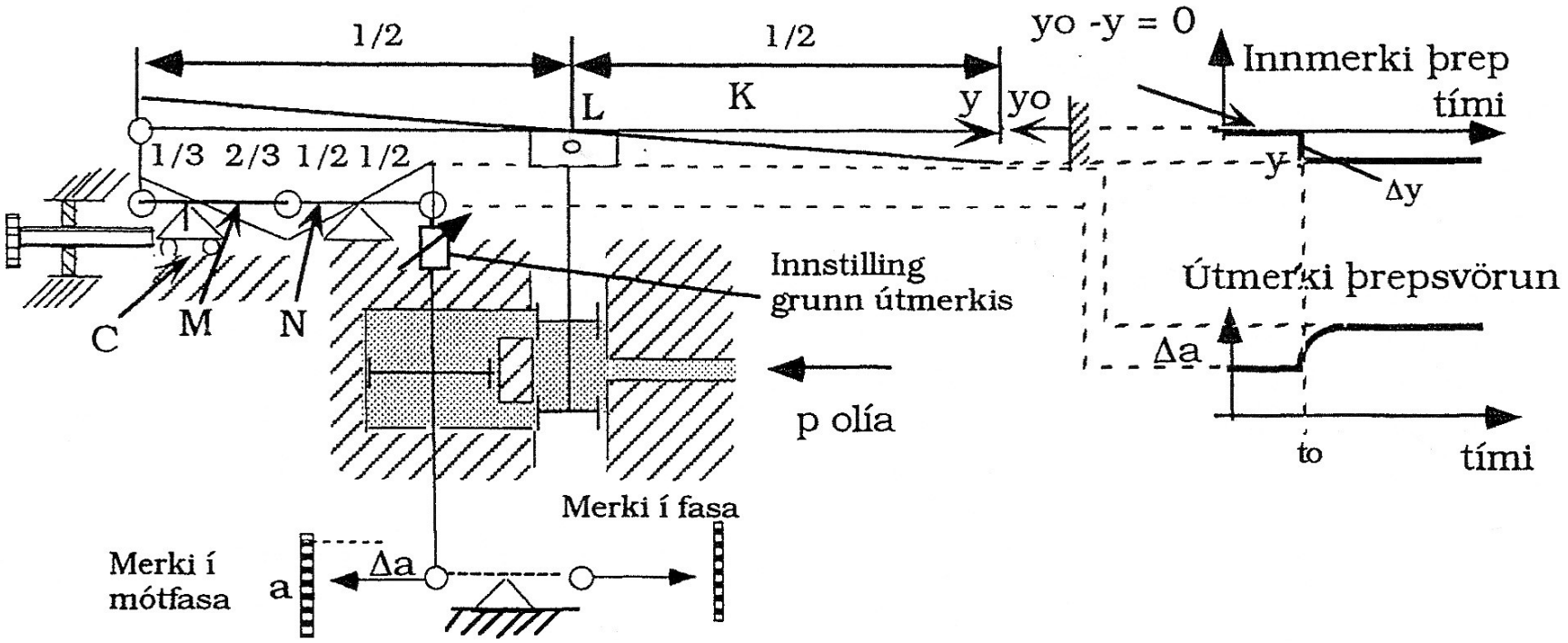

+U CC
R C1
R C2
c
d
K
T 1
T 2
U1,út
U2,út
a
b
U1,inn
U2,inn
E
NPN transistorar
R E
- U EE

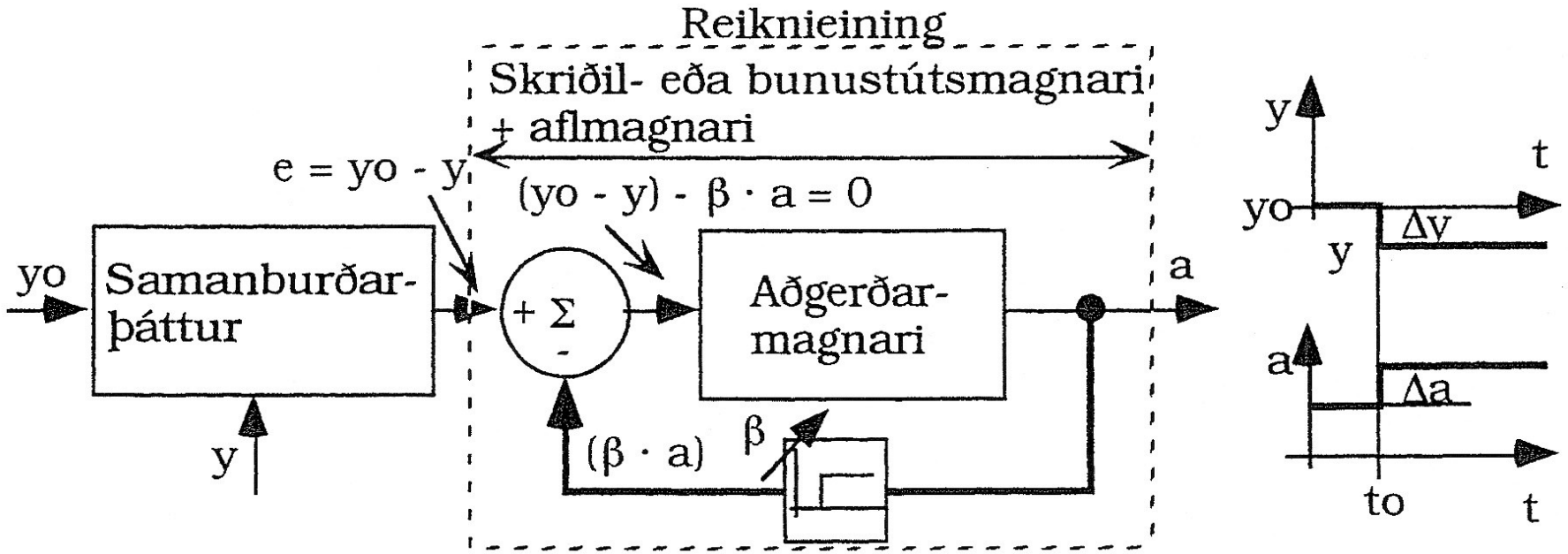

+U CC
c
d
U,út
a
b
-U EE

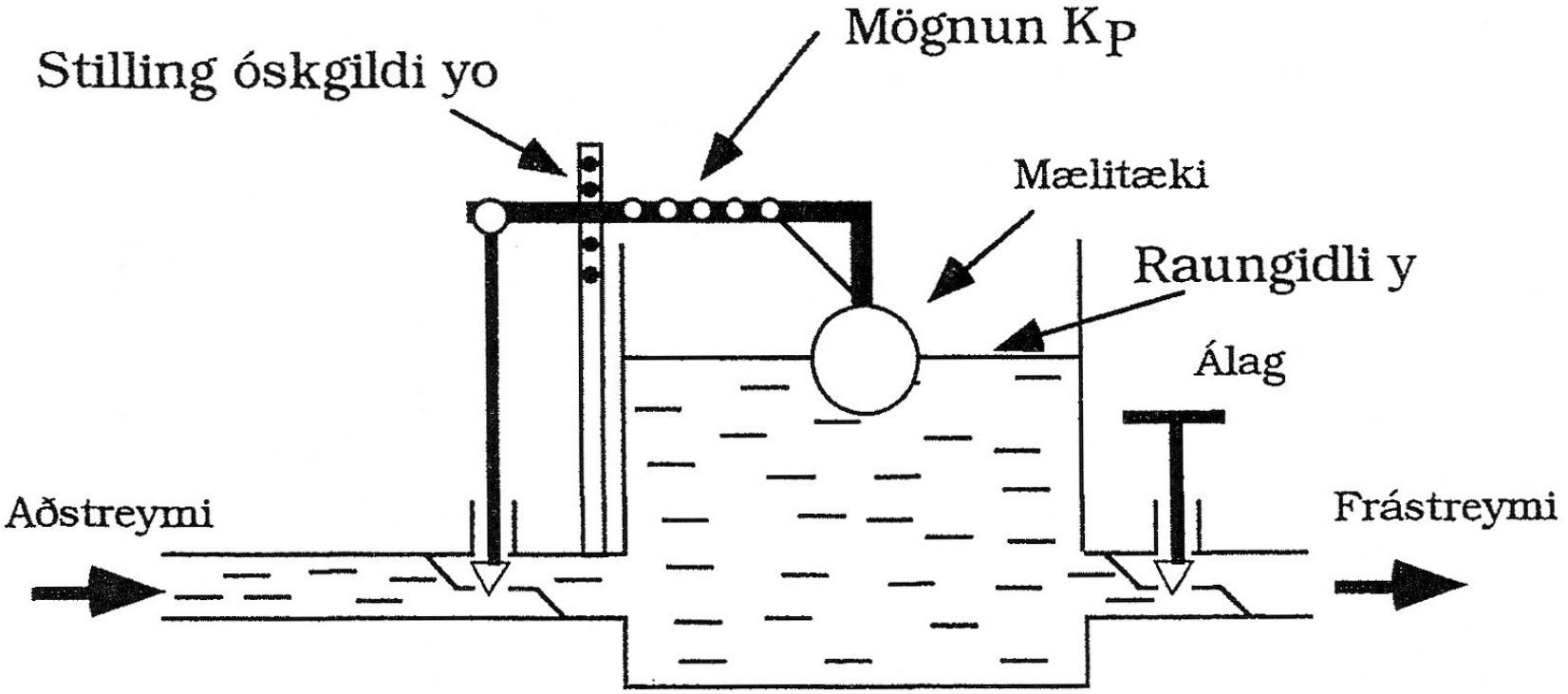
P-reglar

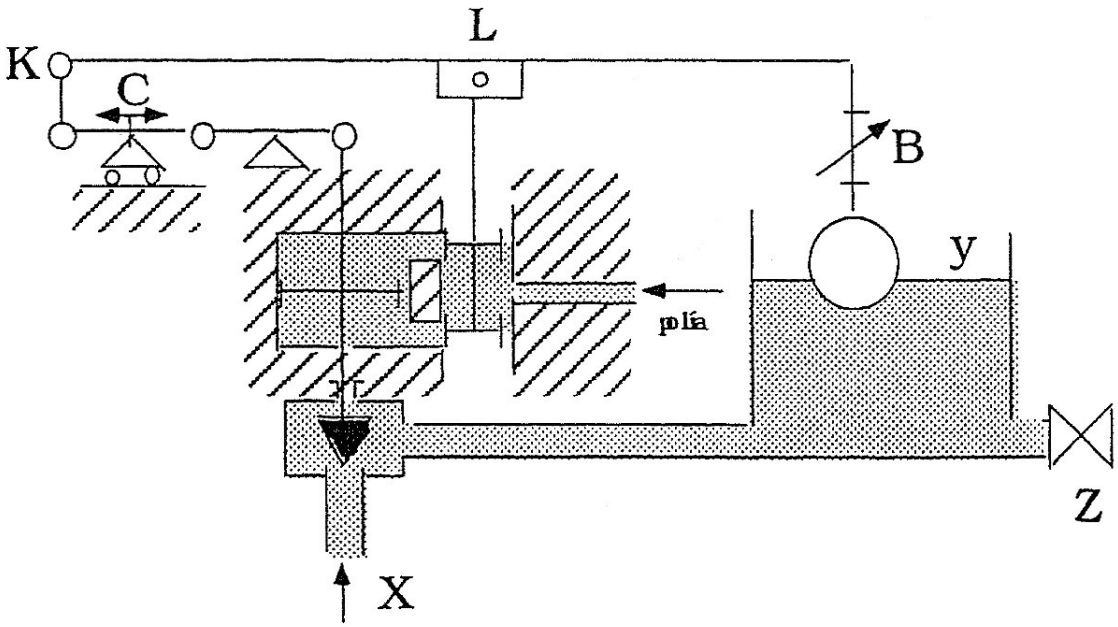
Lýsing	Tengimynd	Þrepsvar
<u>Viðbrögð við þrepsvari</u> Ákveðin breyting á mismuna-merkinu e veldur ákveðinni hlutfallslegri svörun á frámerkinu a_P <u>Stíf bakafærsla</u> er einkenni P-reglunar. Með styrkleika hennar má stjórna mögnuninni Kp. Sé dregið úr styrkleika bakafærslunnar β eykst mögnunin Kp að sama skapi.		

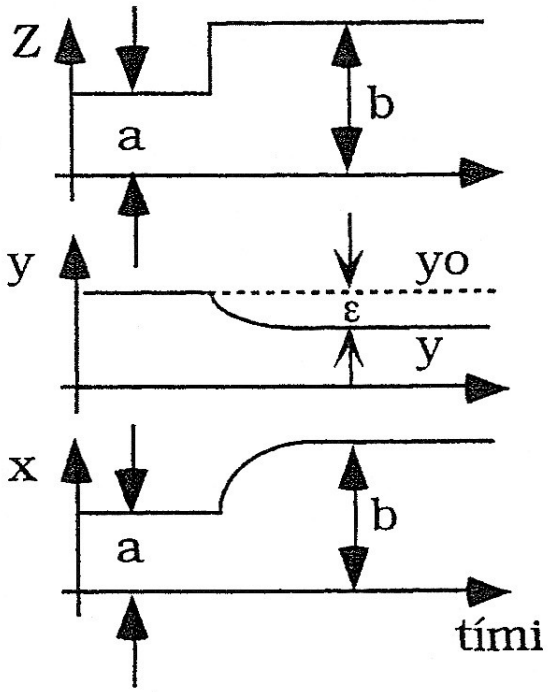
$$a_P = \pm\frac{1}{\beta} \cdot e \; ; \quad a_P = \pm K_P \cdot e$$

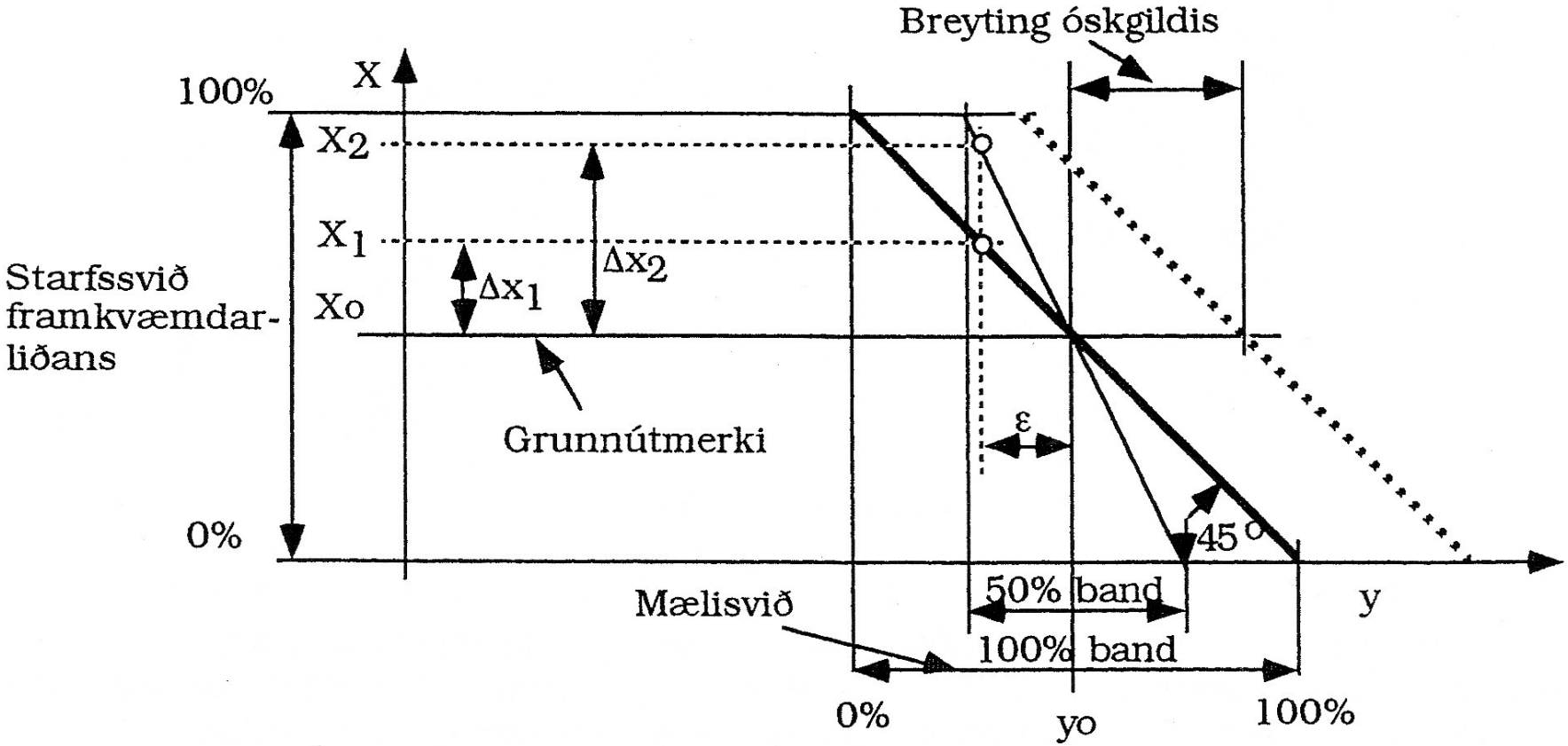

1/2
1/2
L
K
y
yo
yo -y = 0
Innmerki þrep
tími
1/3 2/3 1/2 1/2
-y
Δy
C
M
N
Innstilling
grunn útmerkis
Útmerki þrepsvörun
Δa
p olía
to
tími
Merki í fasa
Merki í
mótfasa
a
Δa

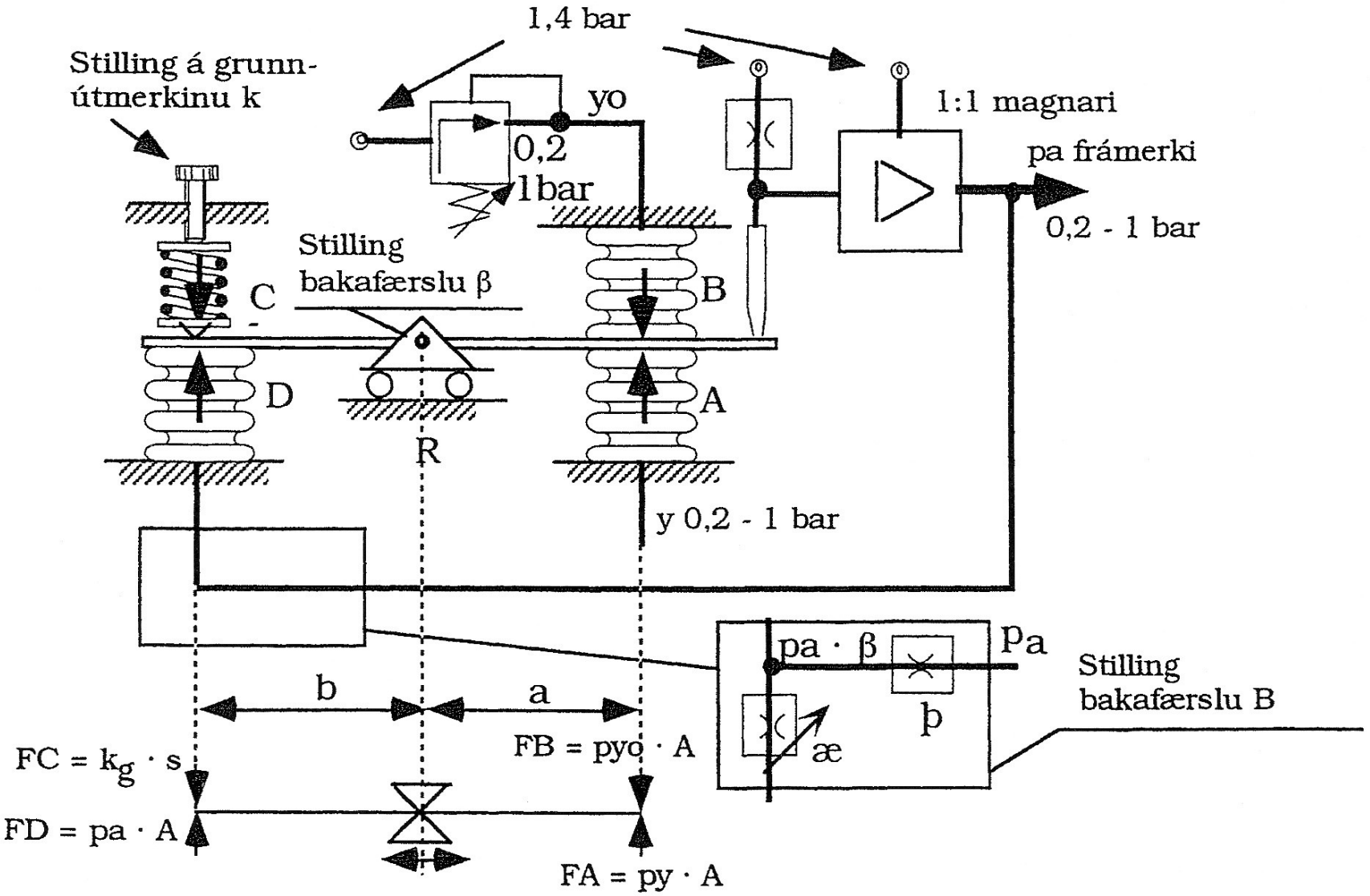

Reiknieining
Skriðil- eða bunustútsmagnari
+ aflmagnari
e = yo - y
(yo - y) - β · a = 0
yo
Samanburðar-
þáttur
y
+ Σ
-
Aðgerðar-
magnari
a
(β · a)
β
y
t
yo
Δy
y
a
Δa
to
t

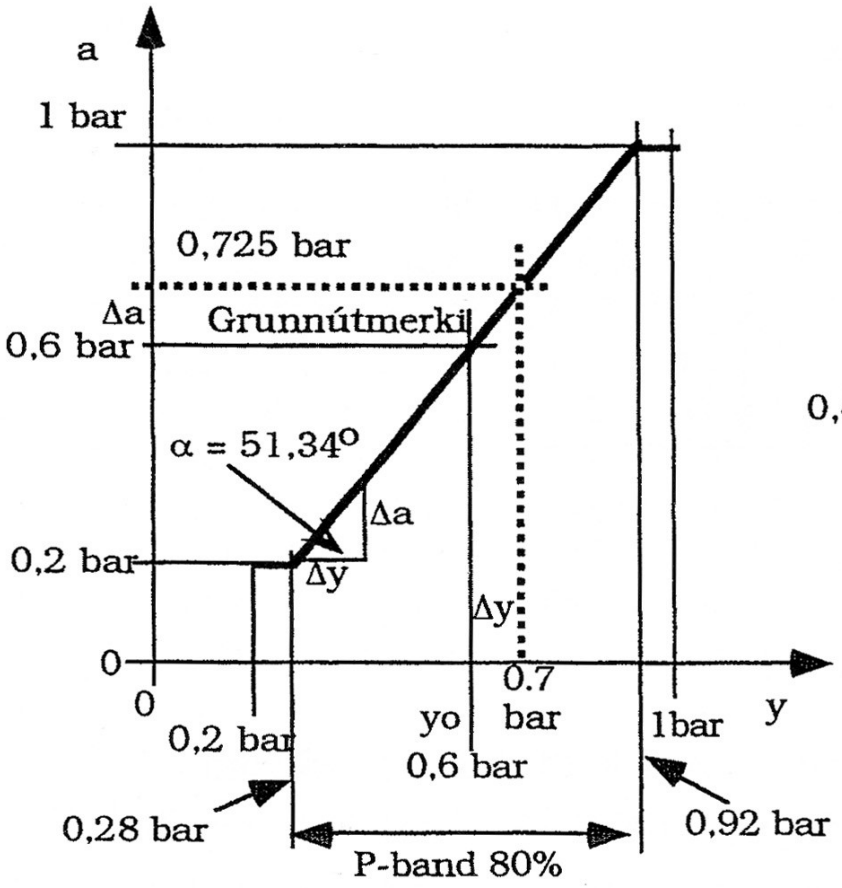

Stilling óskgildi yo
Mögnun Kp
Mælitæki
Raungidli y
Álag
Aðstreymi
Frástreymi


K
C
L
B
y
olía
Z
X

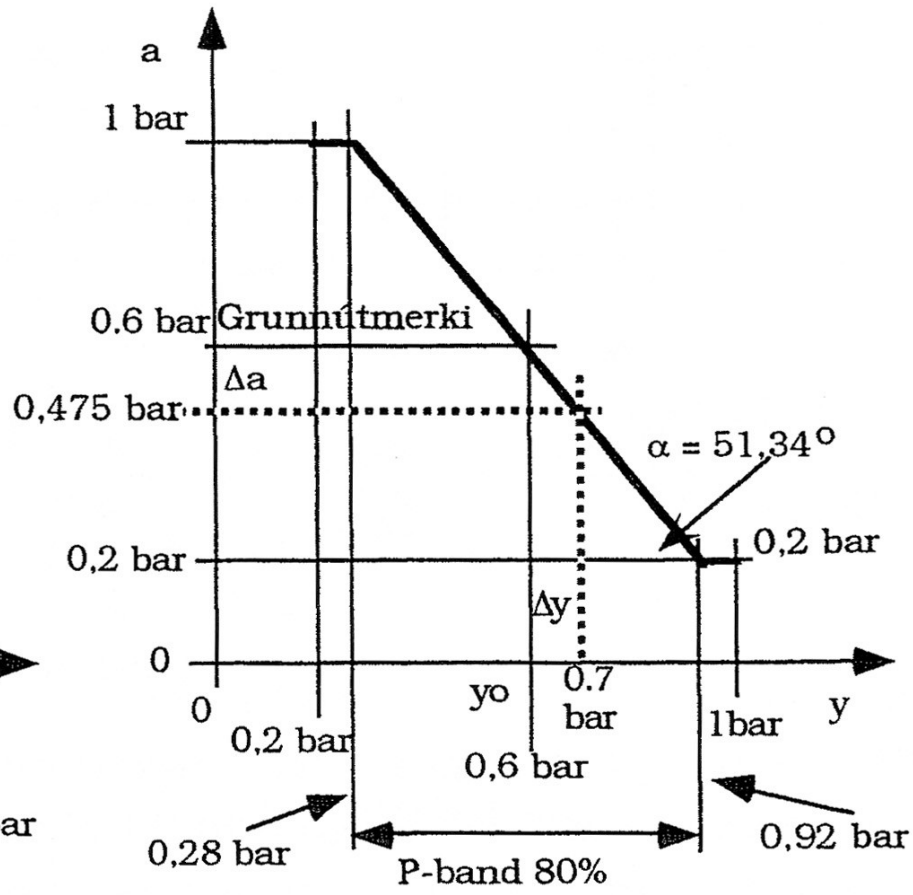

Z
a
b
y
yo
ε
y
x
a
b
tími


Breyting óskgildis
100%
X
X2
X1
Xo
Starfssvið framkvæmdar-liðans
Δx2
Δx1
Grunnútmerki
ε
0%
45°
Mælisvið
50% band
100% band
y
0%
yo
100%

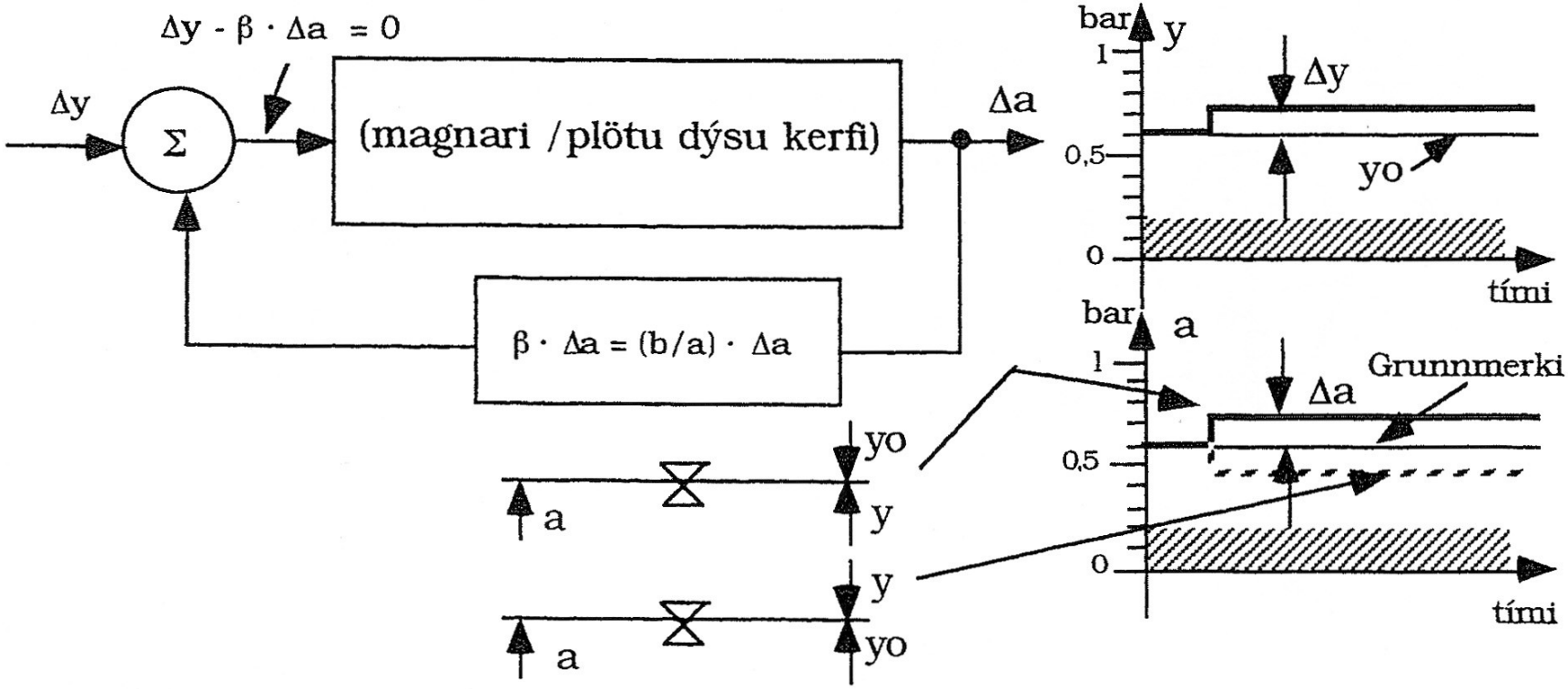

1,4 bar
Stilling á grunn-
útmerkinu k
yo
0,2
1bar
1:1 magnari
pa frámerki
0,2 - 1 bar
Stilling
bakafærslu β
C
B
D
A
R
y 0,2 - 1 bar
pa · β
pa
Stilling
bakafærslu B
b
a
þ
æ
FC = kg · s
FB = pyo · A
FD = pa · A
FA = py · A

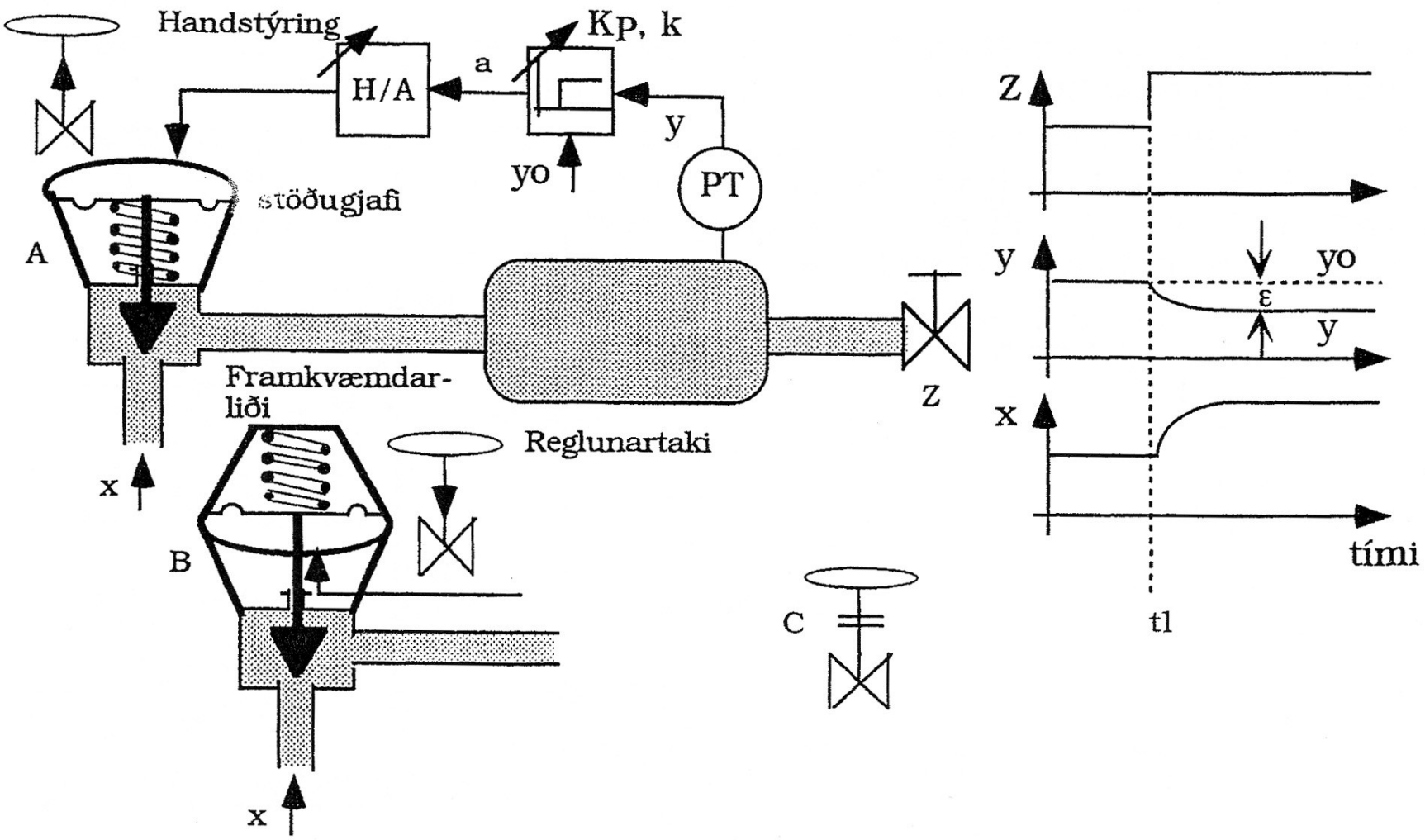


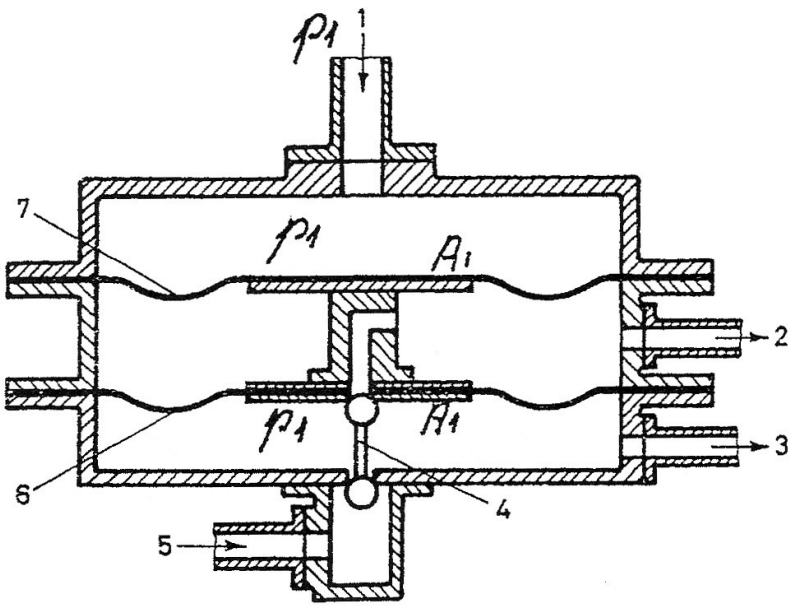
Aðmerki y og frámerki a í fasa

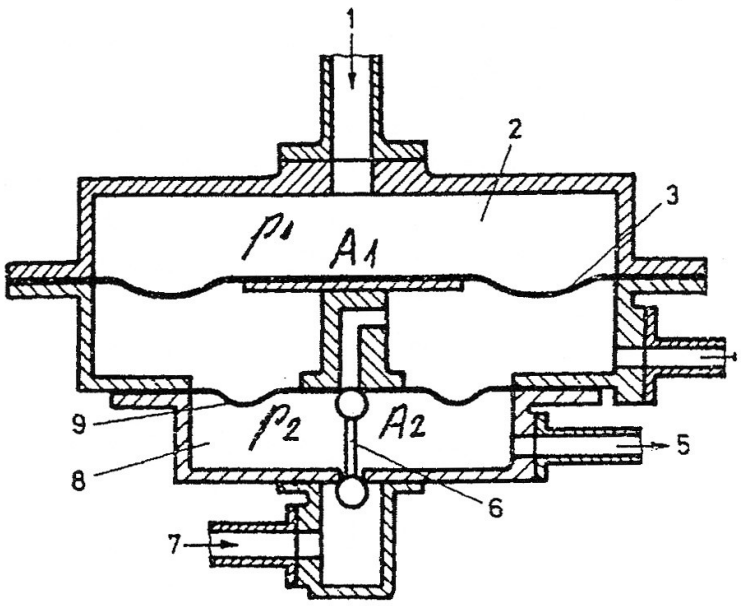


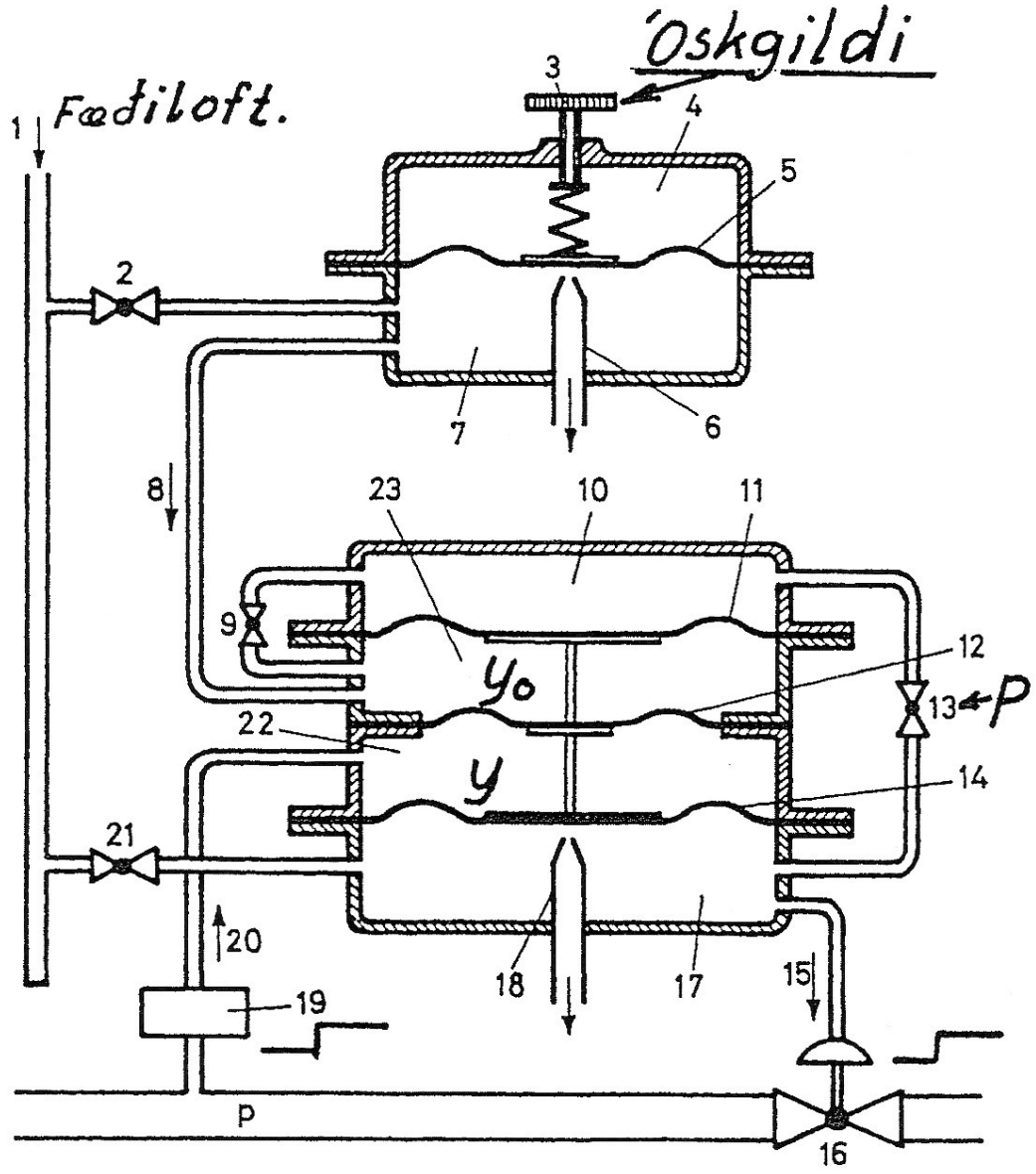
Aðmerki y og frámerki a í mótfasa

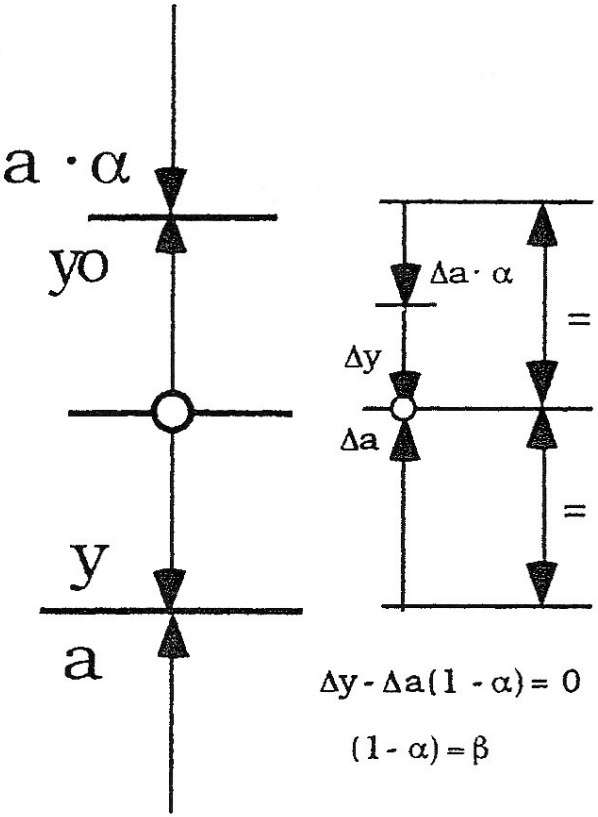

Δy - β · Δa = 0
Δy
Σ
(magnari /plötu dýsu kerfi)
Δa
β · Δa = (b/a) · Δa
yo
a
y
y
a
yo
bar
y
1
0,5
0
Δy
yo
tími
bar
a
1
0,5
0
Δa
Grunnmerki
tími

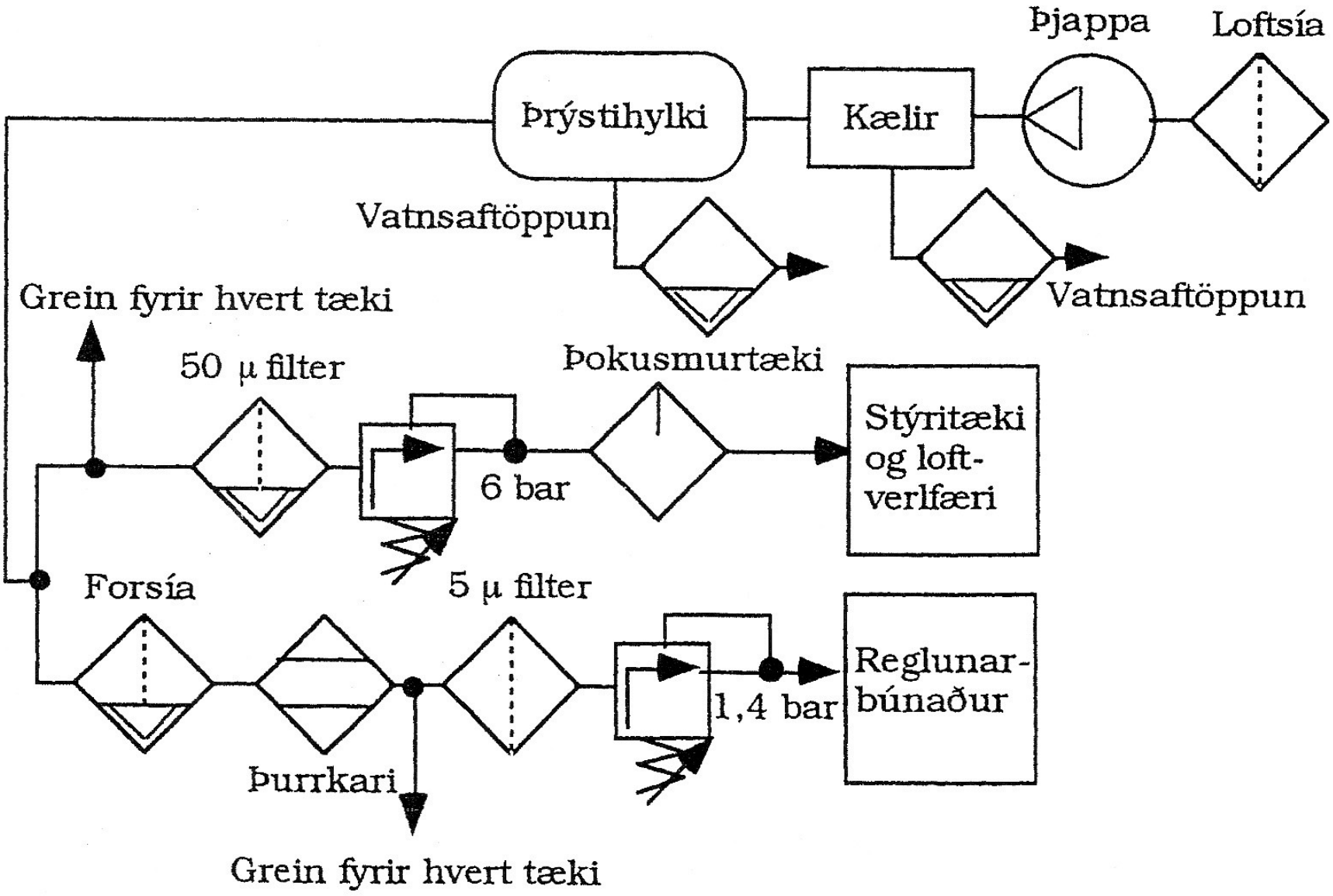

Handstýring
H/A
a
Kp, k
y
yo
PT
stöðugjafi
A
Framkvæmdar-
liði
Reglunartaki
x
B
x
Z
C
Z
y
yo
ε
y
x
tími
tl

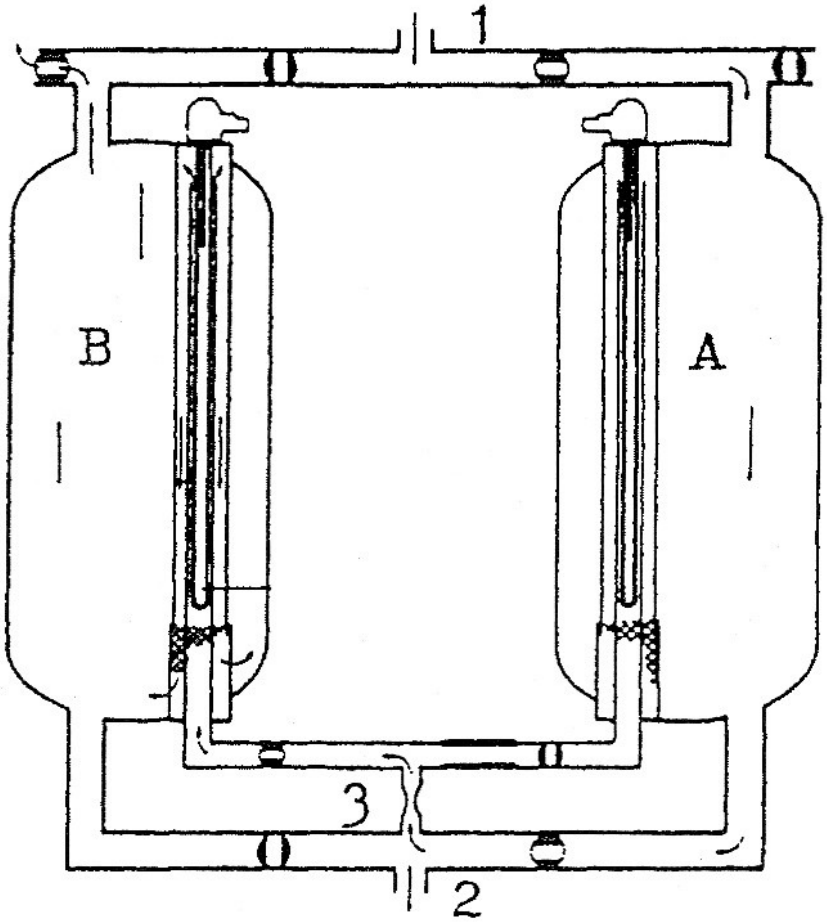

p1
1
7
p1
A1
2
p1
A1
3
6
4
5


1
2
3
p1
A1
9
p2
A2
5
8
6
7

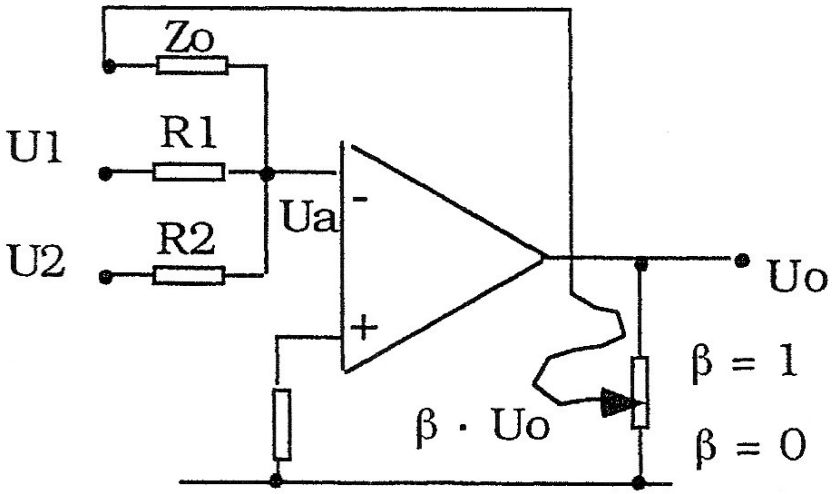

Óskgildi
Fæðiloft.
1
2
3
4
5
6
7
8
9
10
11
12
13
P
14
15
16
17
18
19
20
21
22
23
y₀
y
p

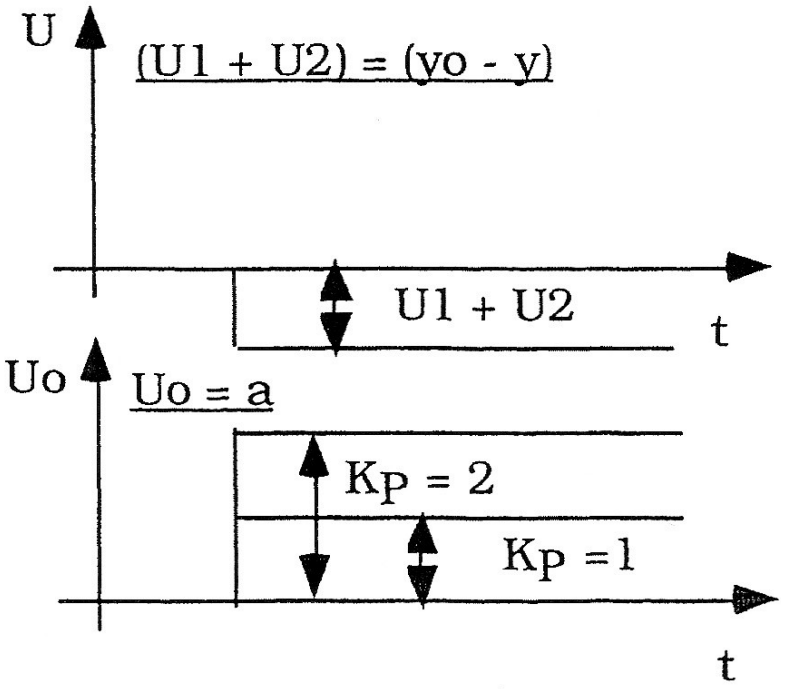

a · α
yo
y
a
Δa · α
=
Δy
Δa
=
Δy - Δa(1 - α) = 0
(1 - α) = β

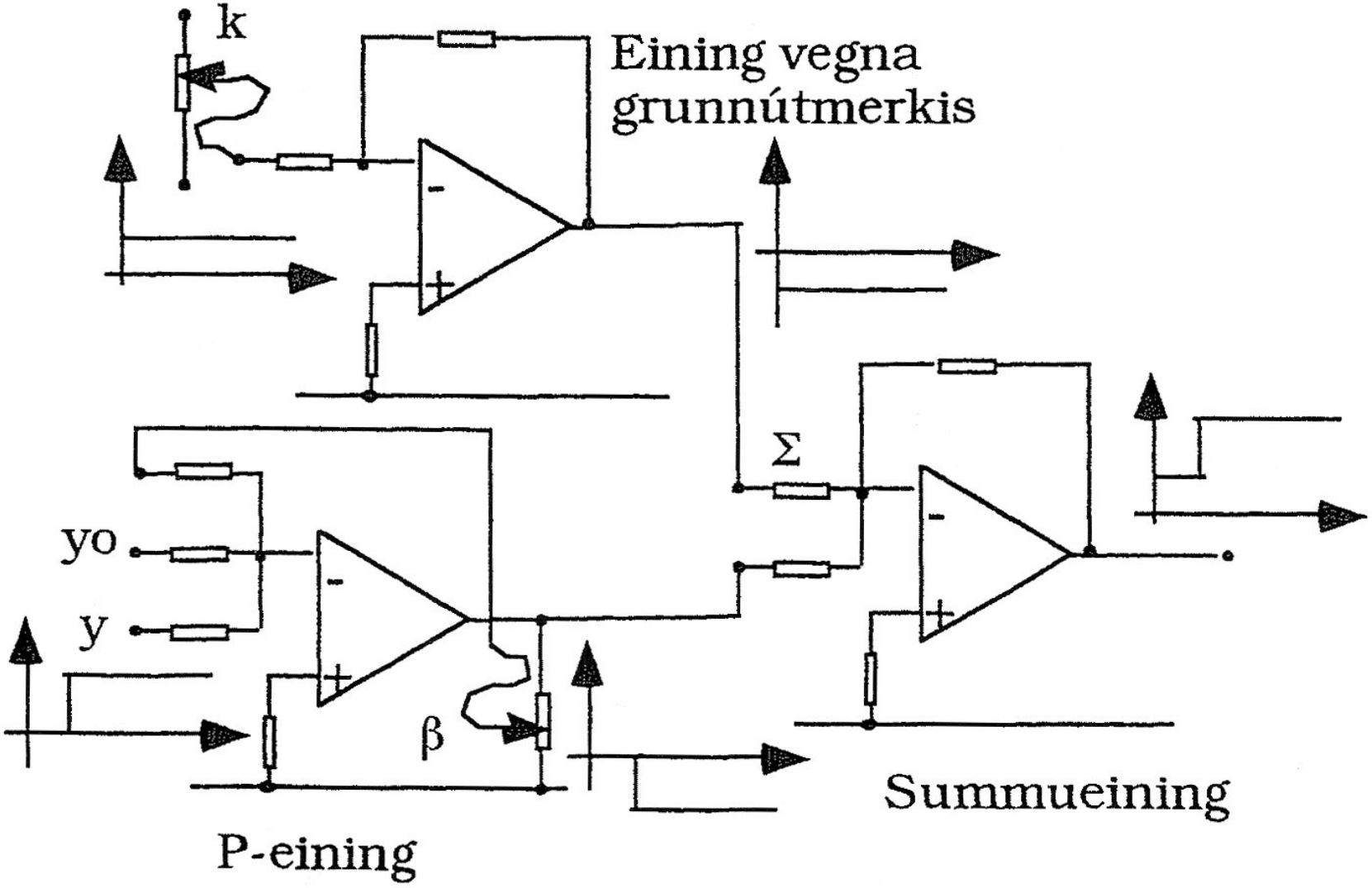

Þjappa
Loftsía
Þrýstihylki
Kælir
Vatnsaftöppun
Vatnsaftöppun
Grein fyrir hvert tæki
50 µ filter
Þokusmurtæki
Stýritæki og loft-verlfæri
6 bar
Forsía
5 µ filter
Reglunar-búnaður
1,4 bar
Þurrkari
Grein fyrir hvert tæki



Riss b


Zo
U1
R1
U2
R2
Ua
-
+
Uo
β = 1
β · Uo
β = 0


U
(U1 + U2) = (yo - y)
U1 + U2
t
Uo
Uo = a
Kp = 2
Kp =1
t

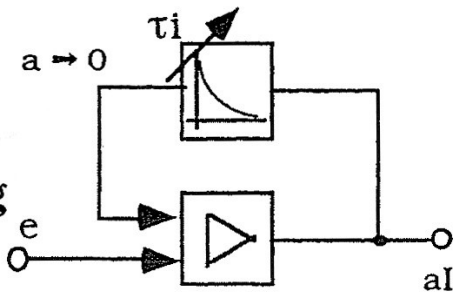

k
Eining vegna
grunnútmerkis
Σ
yo
y
β
P-eining
Summueining

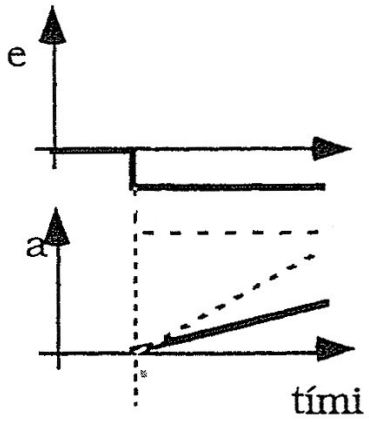
I-eining

Lýsing	Tengimynd	Þrepsvar

Þrepsvar

I-eining svarar þrepi með því að senda út merki sem vex með ákveðnum hraða. Eins og fram kemur í formúlunum þá er <u>hraðinn háður mismunastærðinni e og hoptímanum τi.</u> τi stjórnar því hve hratt bakafærslan eyðist eða hopar.

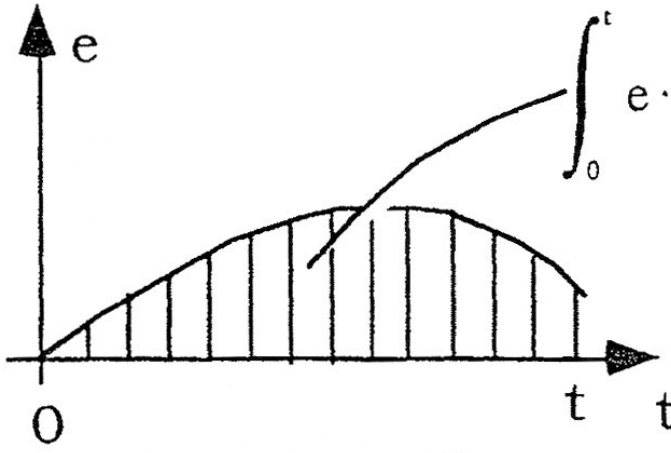




Sett er <u>eftirgefanleg bakafærsla</u> á aðgerðamagnarann, en hún vinnur fyrst með fullum styrkleika en síðan fer hún minnkandi en þá eykst mögnunin og nálgast óendanlegt eða þau mörk sem aðgerðamagnarinn setur.

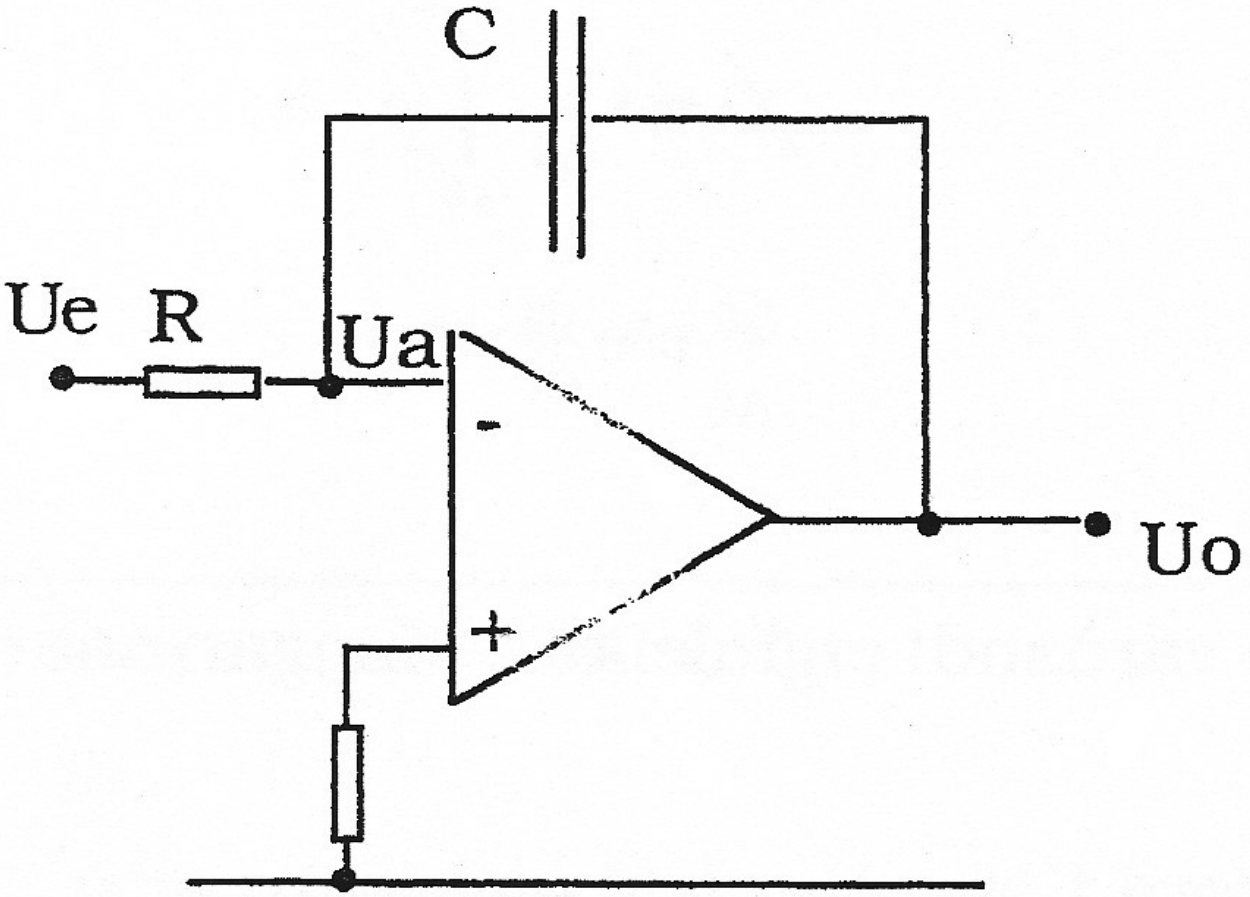
$$a = \mp \frac{1}{\tau i} \int_0^t e \cdot dt;$$

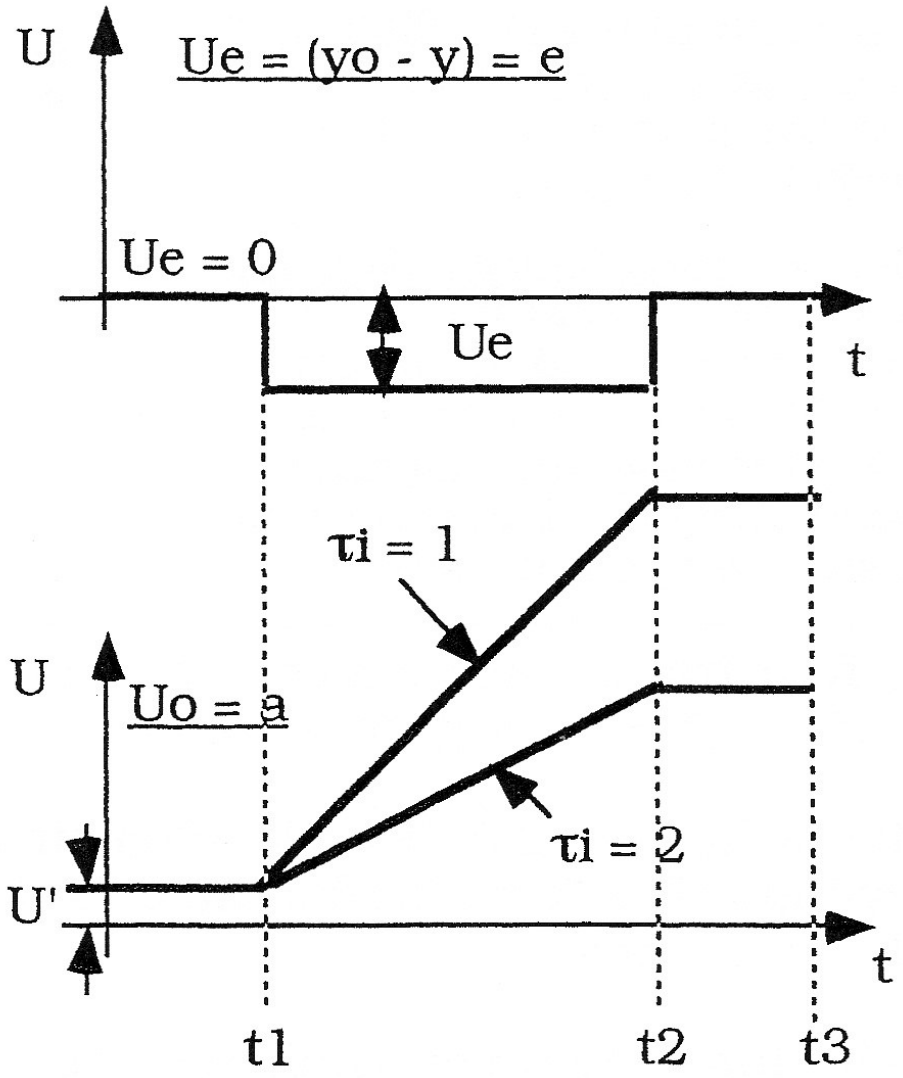
$$\frac{\Delta a}{\Delta t} \text{ eða } \frac{da}{dt} = \mp \frac{1}{\tau i} \cdot e;$$

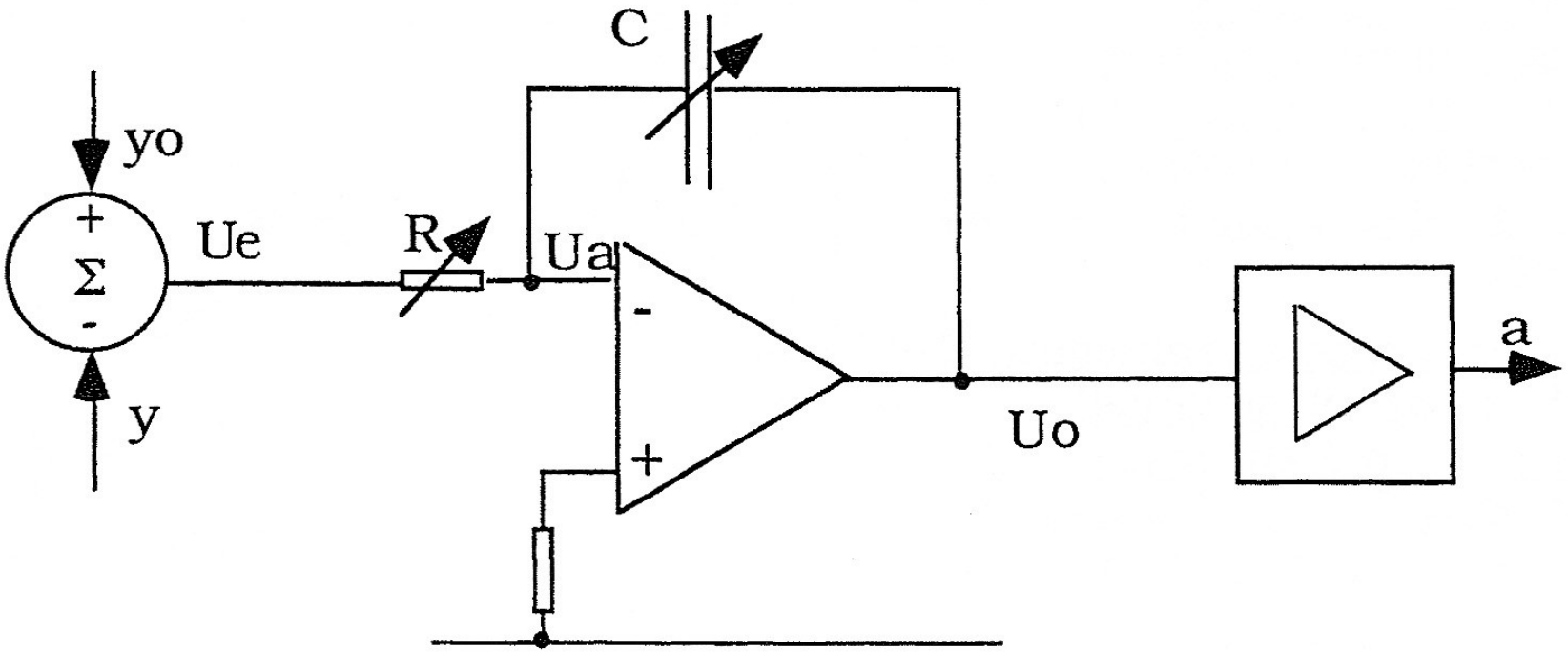


$$\int_0^t e \cdot dt$$

$$a = \pm \frac{1}{\tau i} \int_0^t e \cdot dt + \text{fasti} ;$$


C
Ue
R
Ua
-
+
Uo


U
Ue = (yo - y) = e
Ue = 0
Ue
t
τi = 1
U
Uo = a
τi = 2
U'
t
t1
t2
t3


C
yo
+
Σ
-
y
Ue
R
Ua
-
+
Uo
a

PI-eining

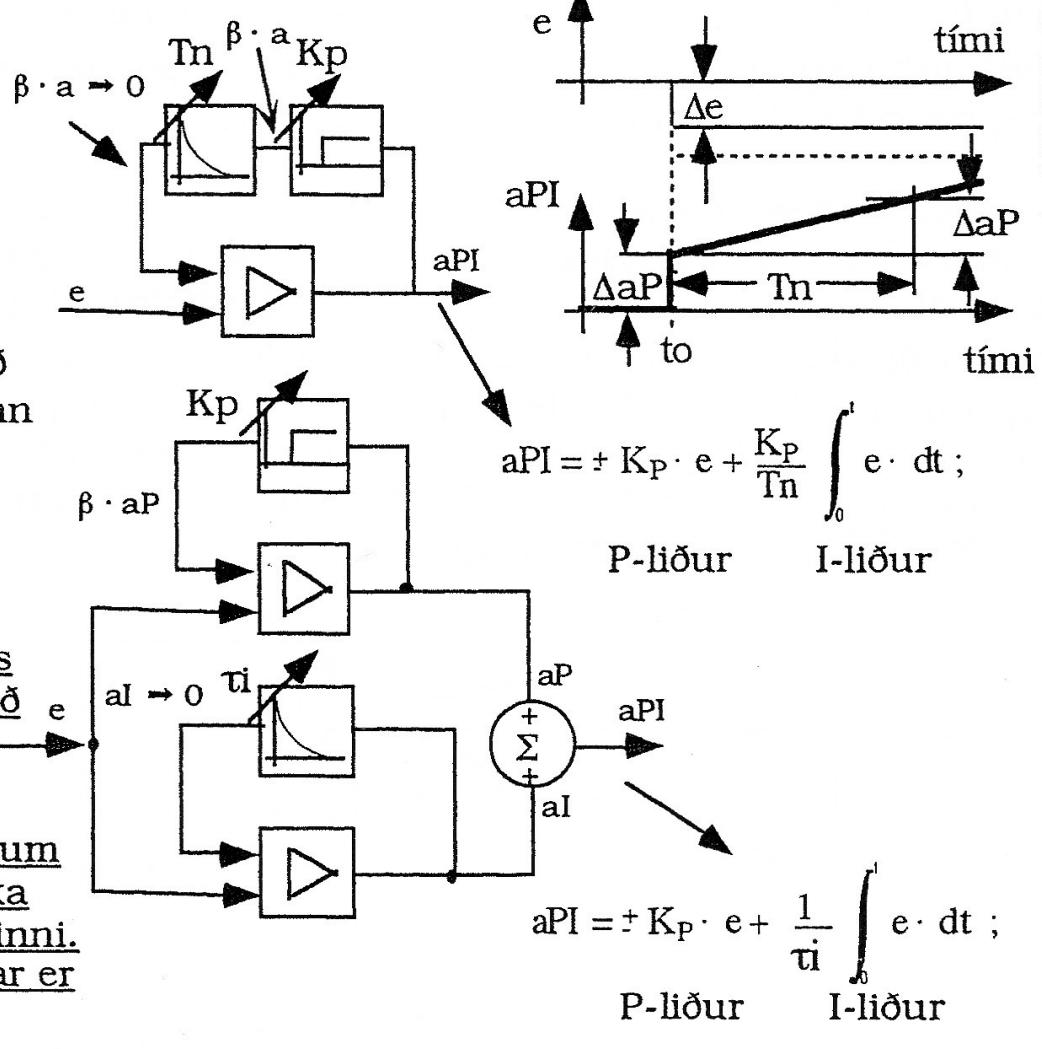
Lýsing

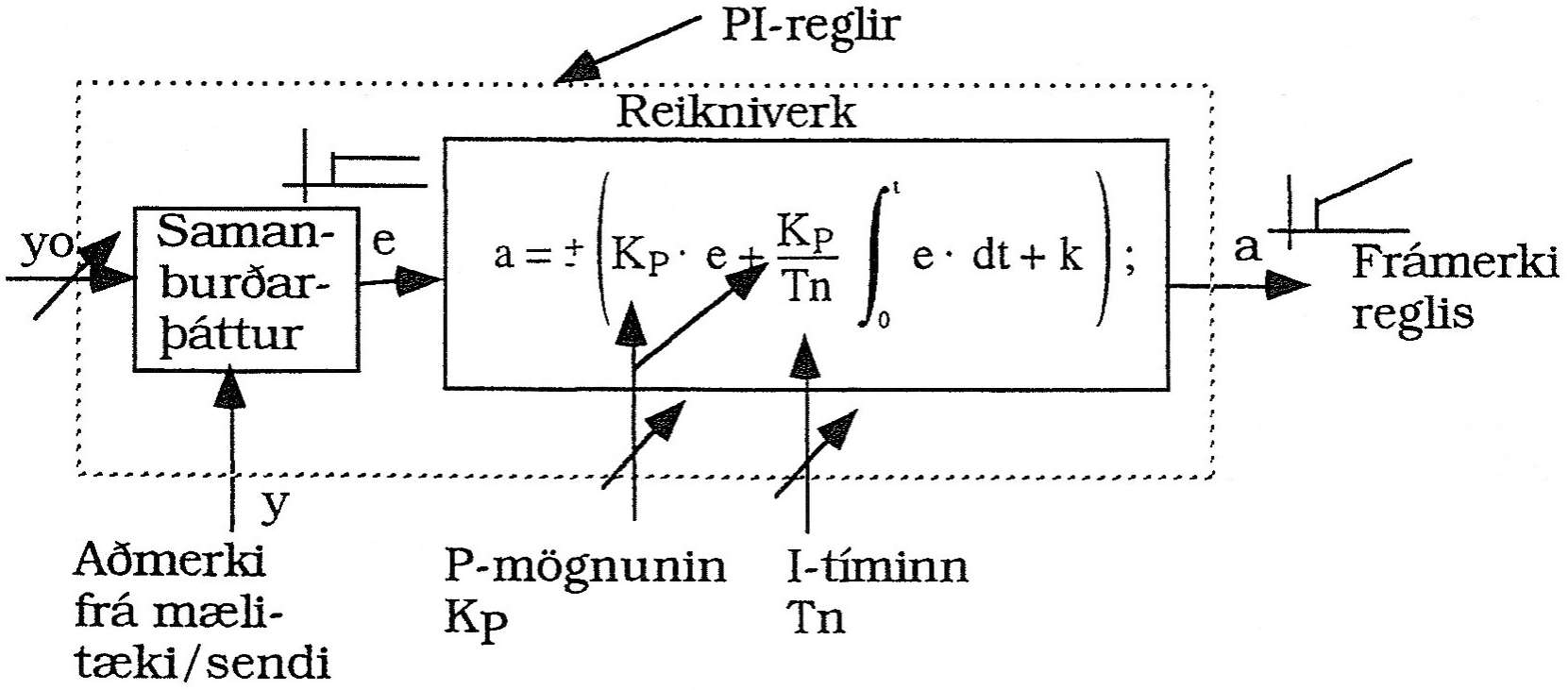
Tengimynd

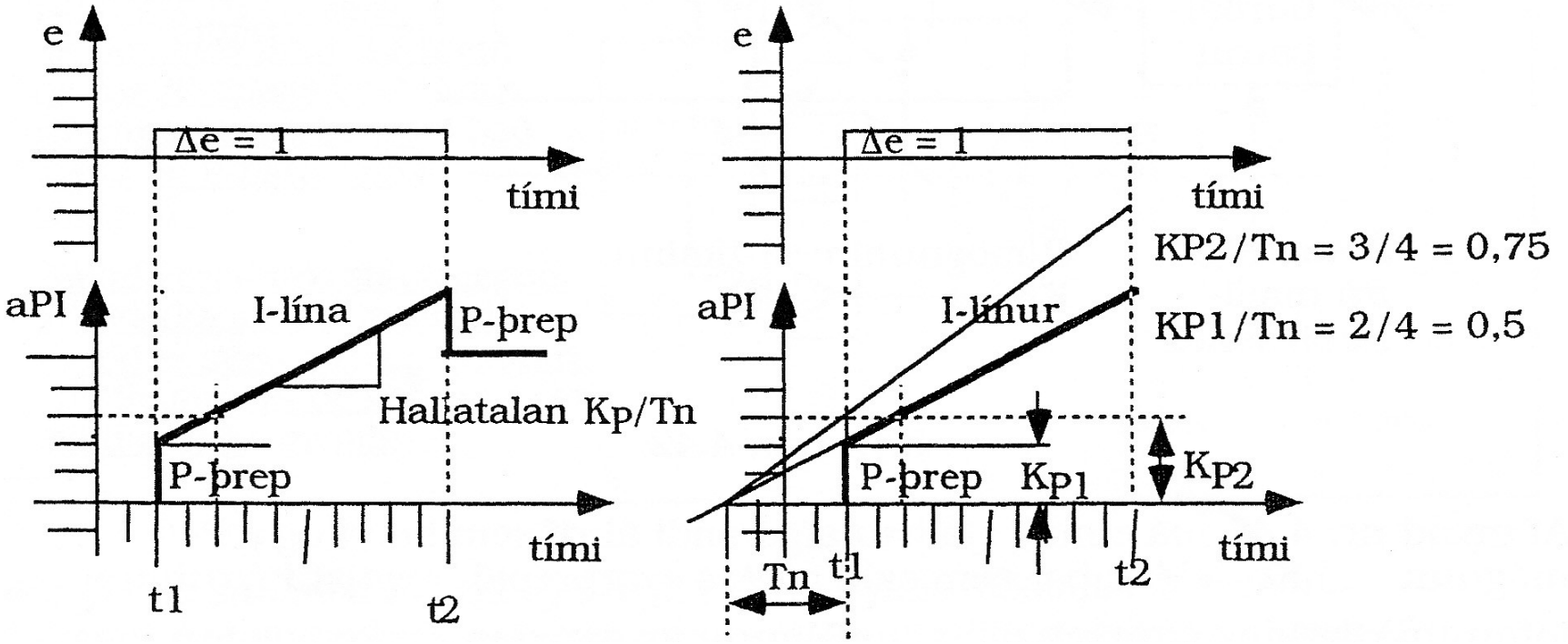
Þrepsvar

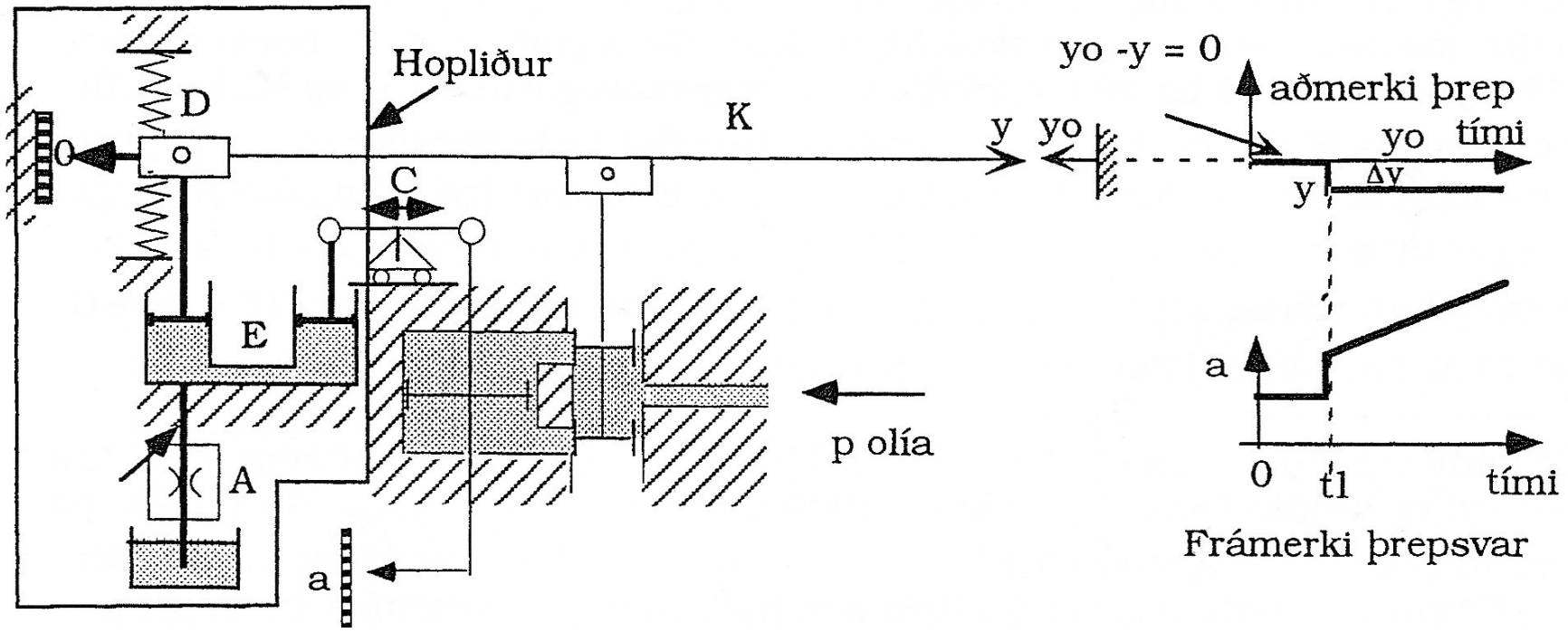
Viðbrögð við þrepsvari
Fyrst í stað einkennist þrepsvarið af eiginleikum P-reglisins, að svara þrepi með þrepi. Síðan koma I-eiginleikarnir inn sem er ákveðinn breytihraði útmerkisins a. Hafa má áhrif á þrepsvarið ΔaP með mögnuninni Kp og I-tímann með stillihnappinum Tn.
Á þrepsvarinu kemur fram skilgreining I-tímans Tn en það er sá tími sem líður frá þrepi og þar til tillegg I-þáttarins til útmerkisins er orðið það sama og P-þáttarins í upphafi.

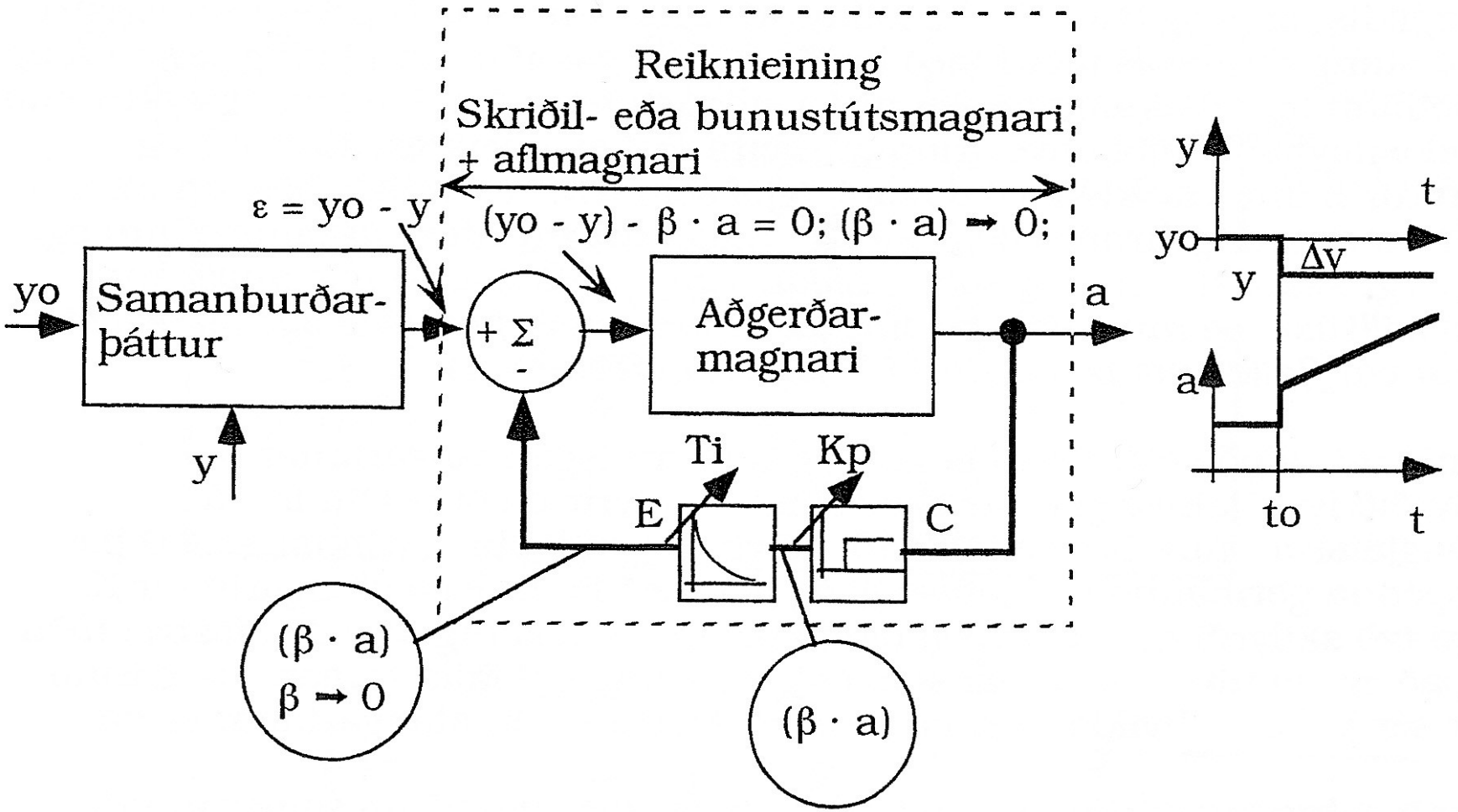
Bakafærsla með stýranlegum styrkleika og eftirgefanleika (hopi) er sýnd á efri myndinni. Hliðtenging P- og I-einingar er sýnd á neðri myndinni.

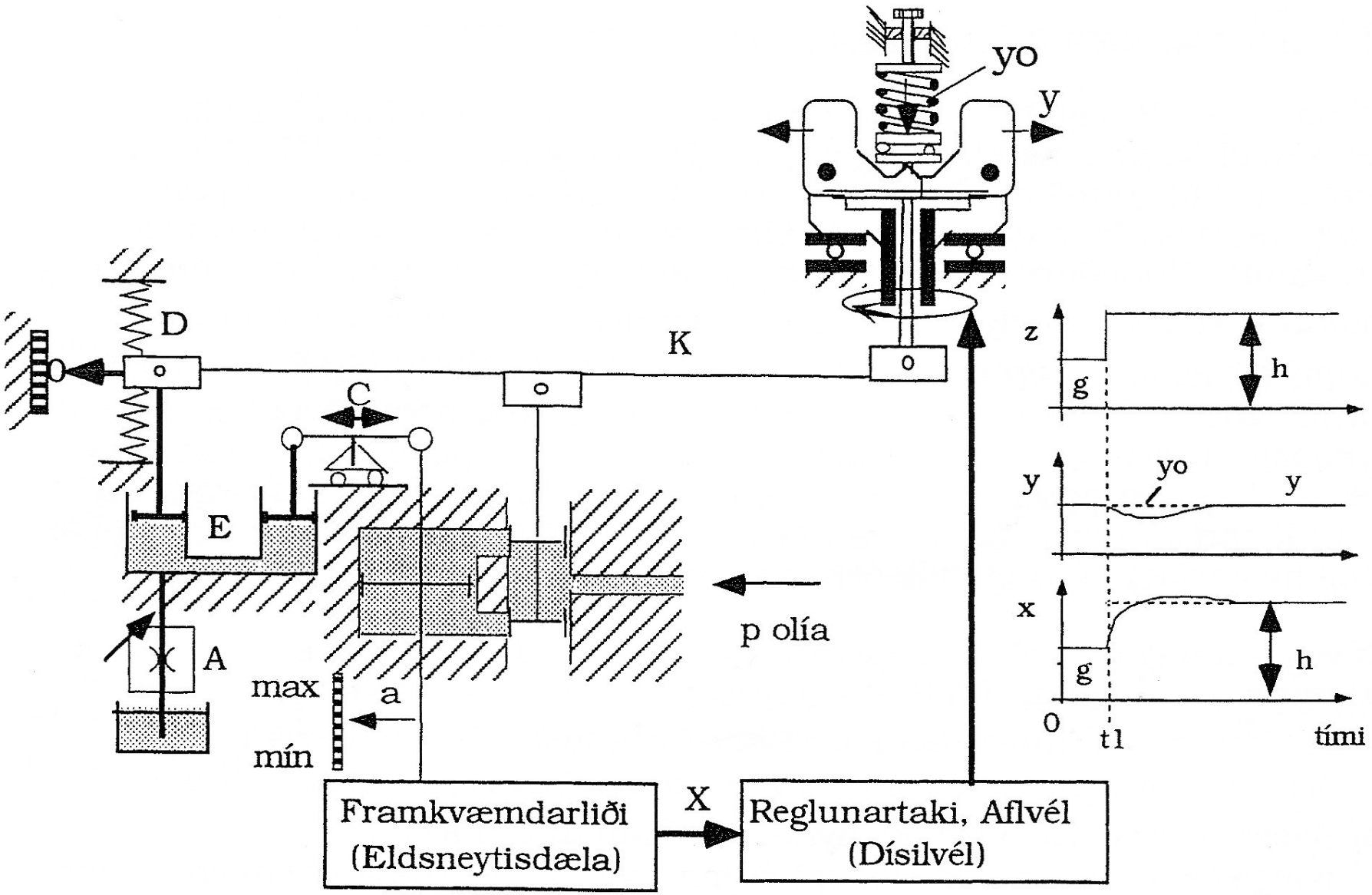


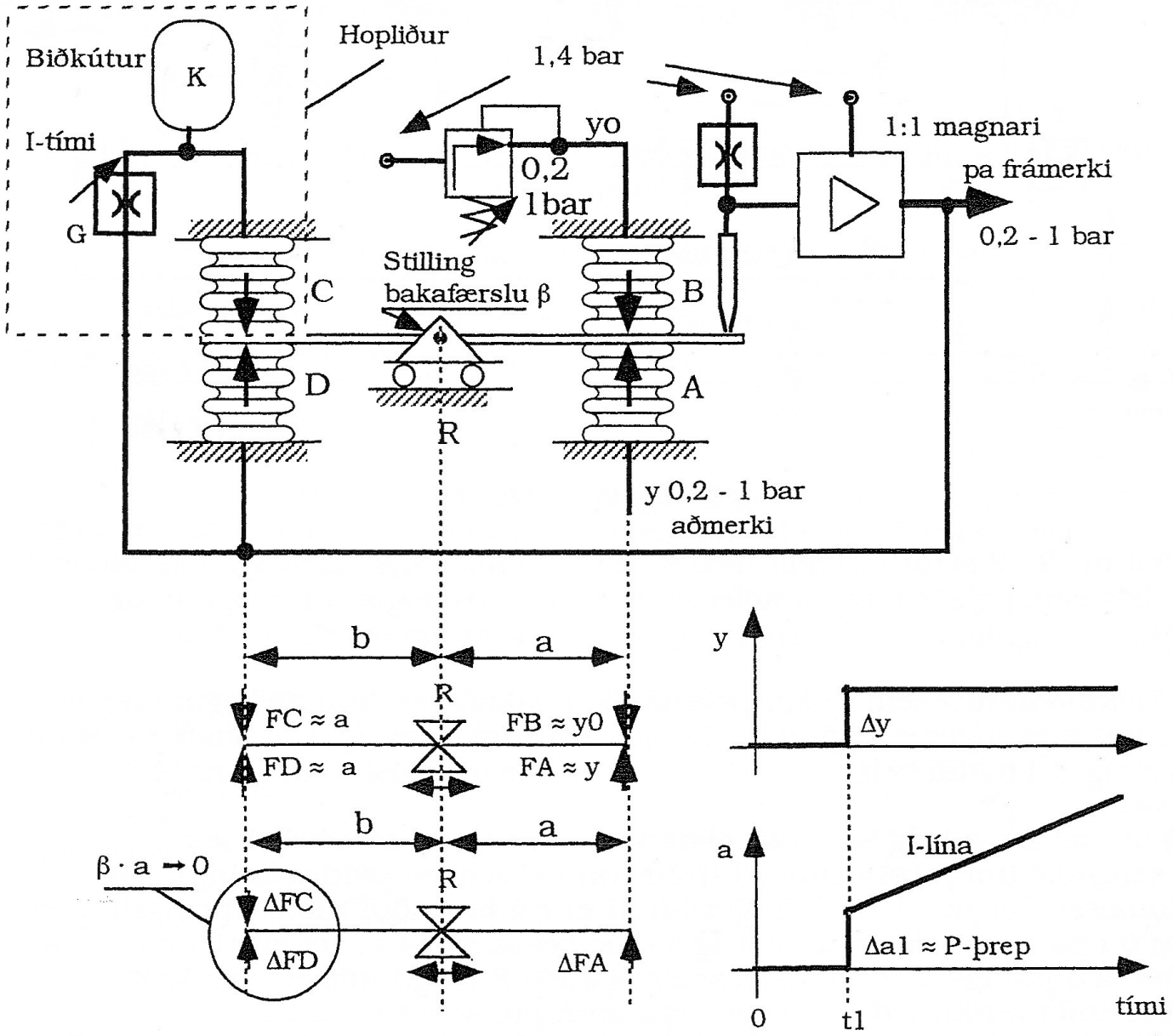

PI-reglir
Reikniverk
yo
Saman-
burðar-
þáttur
e
$a = \pm\left(K_P \cdot e \pm \frac{K_P}{Tn}\int_0^t e \cdot dt + k\right);$
a
Frámerki
reglis
y
Aðmerki
frá mæli-
tæki/sendi
P-mögnunin
KP
I-tíminn
Tn

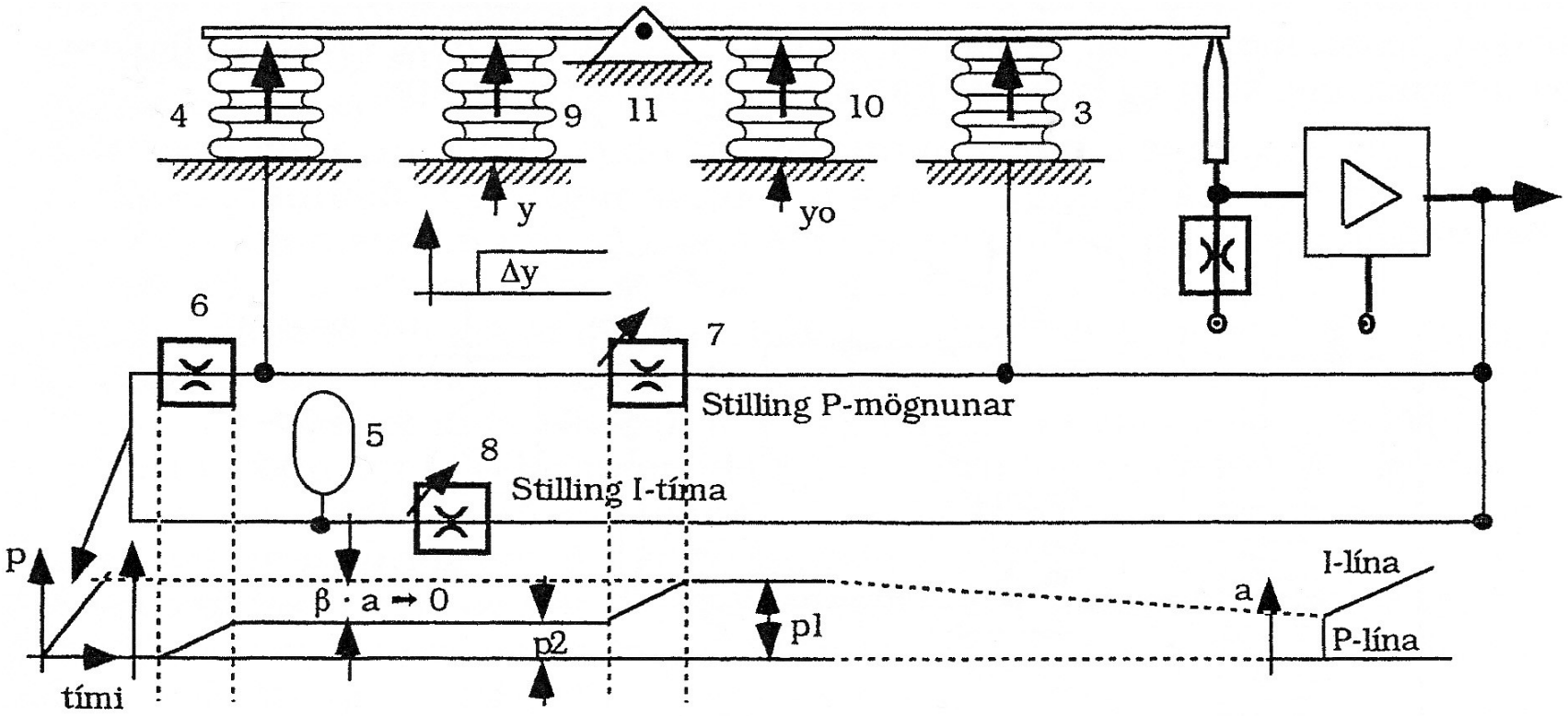

e
Δe = 1
tími
aPI
I-lína
P-þrep
Halíatalan Kp/Tn
P-þrep
tími
t1
t2
e
Δe = 1
tími
KP2/Tn = 3/4 = 0,75
KP1/Tn = 2/4 = 0,5
aPI
I-línur
P-þrep
KP1
KP2
tími
Tn
t1
t2

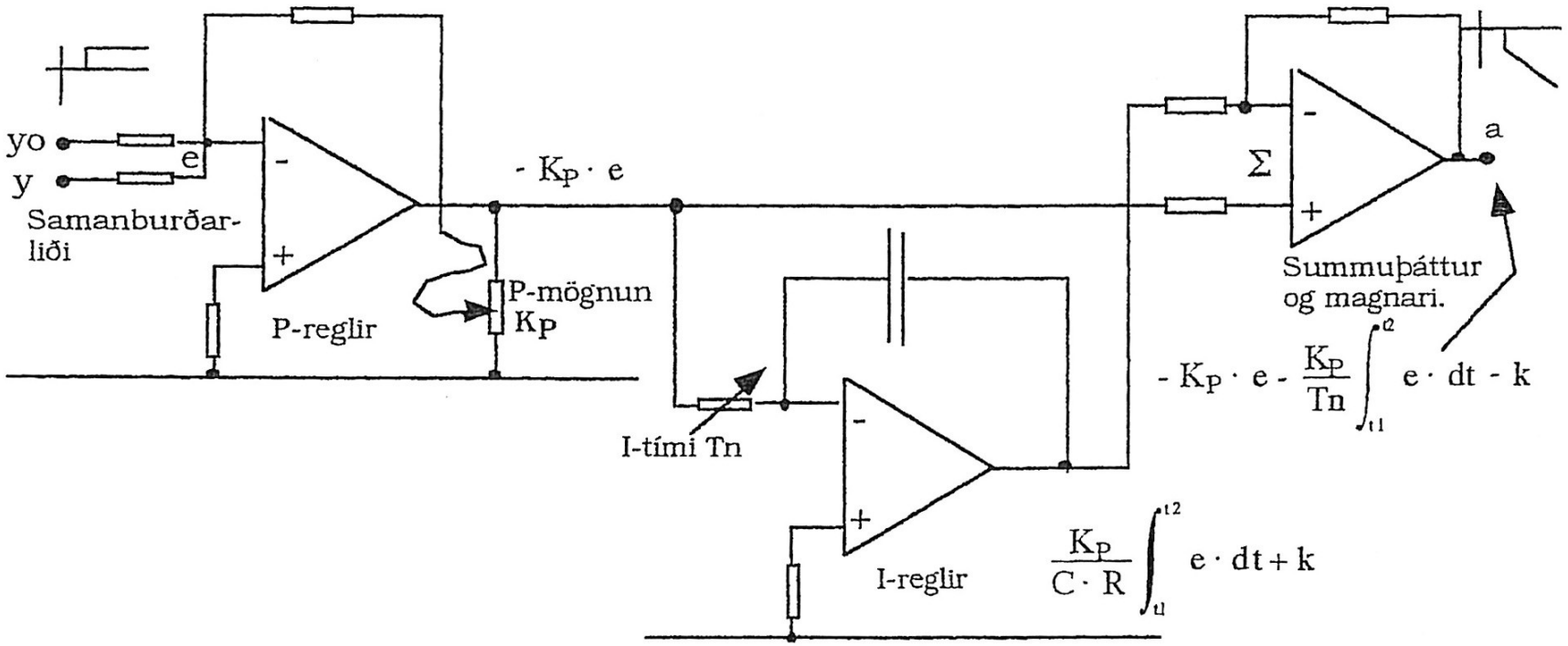

Hopliður
D
K
C
E
A
a
p olía
yo -y = 0
aðmerki þrep
y yo
yo tími
Δy
y
a
0
t1
tími
Frámerki þrepsvar

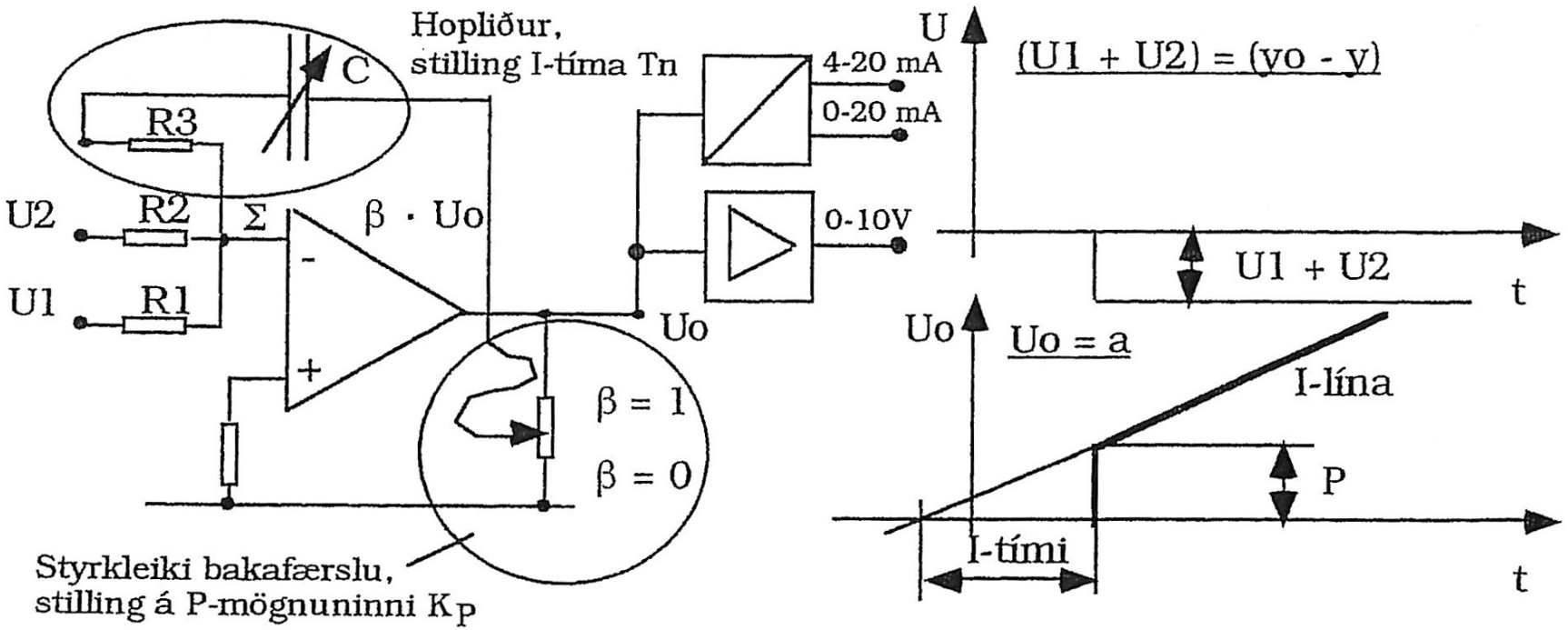

Reiknieining
Skriðil- eða bunustútsmagnari
+ aflmagnari
ε = yo - y
(yo - y) - β · a = 0; (β · a) → 0;
yo
Samanburðar-
þáttur
y
+ Σ
-
Aðgerðar-
magnari
a
Ti
Kp
E
C
(β · a)
β → 0
(β · a)
y
t
yo
Δy
y
a
to
t

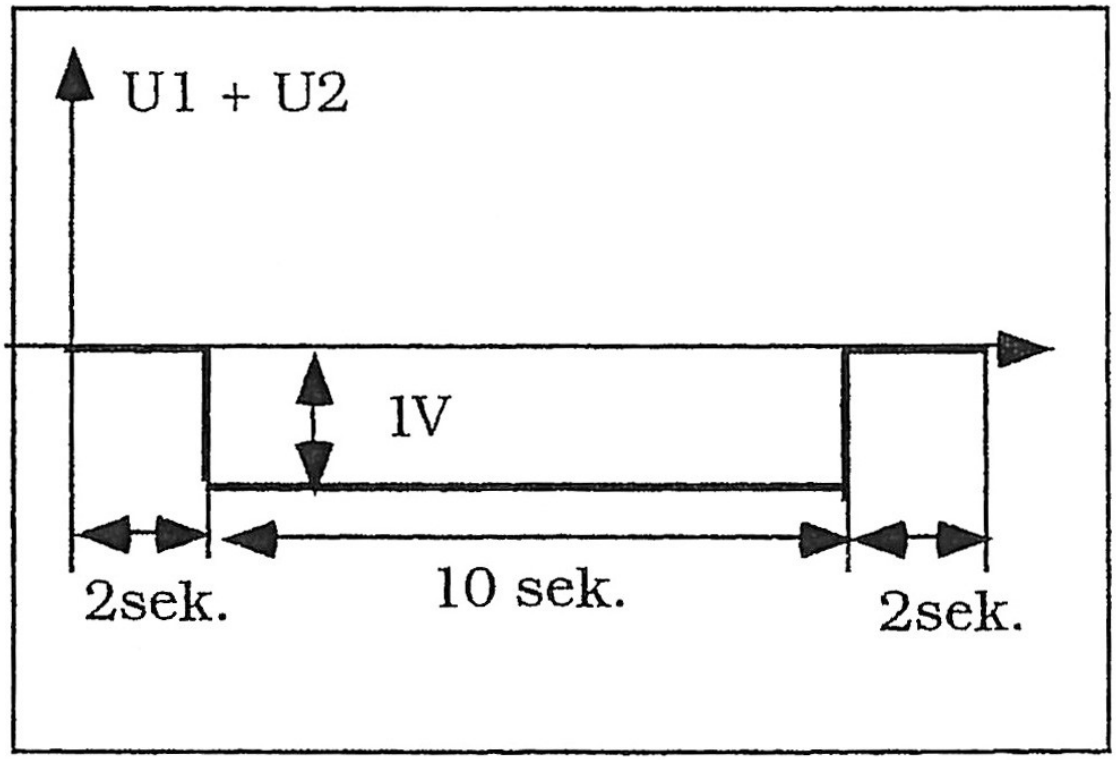

yo
y
D
K
C
E
A
p olía
max
a
mín
z
g
h
y
yo
y
x
g
h
0
t1
tími
Framkvæmdarliði
(Eldsneytisdæla)
X
Reglunartaki, Aflvél
(Dísilvél)


Biðkútur
K
Hopliður
1,4 bar
yo
0,2
1bar
1:1 magnari
pa frámerki
0,2 - 1 bar
I-tími
G
C
Stilling
bakafærslu β
B
D
A
R
y 0,2 - 1 bar
aðmerki
b
a
R
FC ≈ a
FB ≈ y0
FD ≈ a
FA ≈ y
b
a
β · a → 0
R
ΔFC
ΔFD
ΔFA
y
Δy
a
I-lína
Δa1 ≈ P-þrep
0
t1
tími


4
9
11
10
3
y
yo
Δy
6
7
Stilling P-mögnunar
5
8
Stilling I-tíma
P
β · a → 0
p2
p1
a
I-lína
P-lína
tími


yo
y
e
Samanburðar-
liði
P-reglir
P-mögnun
KP
- KP · e
I-tími Tn
I-reglir
Σ
Summuþáttur
og magnari.
a
- KP · e - KP/Tn ∫ e · dt - k
KP/C · R ∫ e · dt + k


Hopliður,
stilling I-tíma Tn
C
R3
U2
R2
Σ
β · Uo
U1
R1
-
+
Uo
4-20 mA
0-20 mA
0-10V
β = 1
β = 0
Styrkleiki bakafærslu,
stilling á P-mögnuninni KP
U
(U1 + U2) = (yo - y)
U1 + U2
t
Uo
Uo = a
I-lína
P
I-tími
t

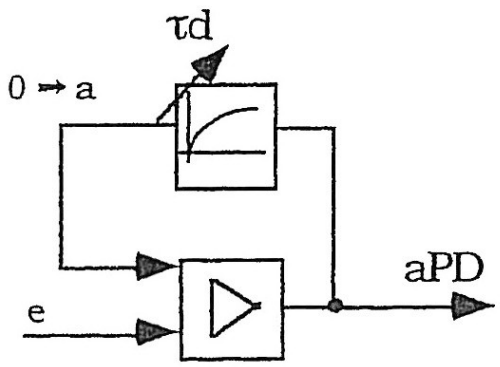

U1 + U2
1V
2sek.
10 sek.
2sek.

D-eining

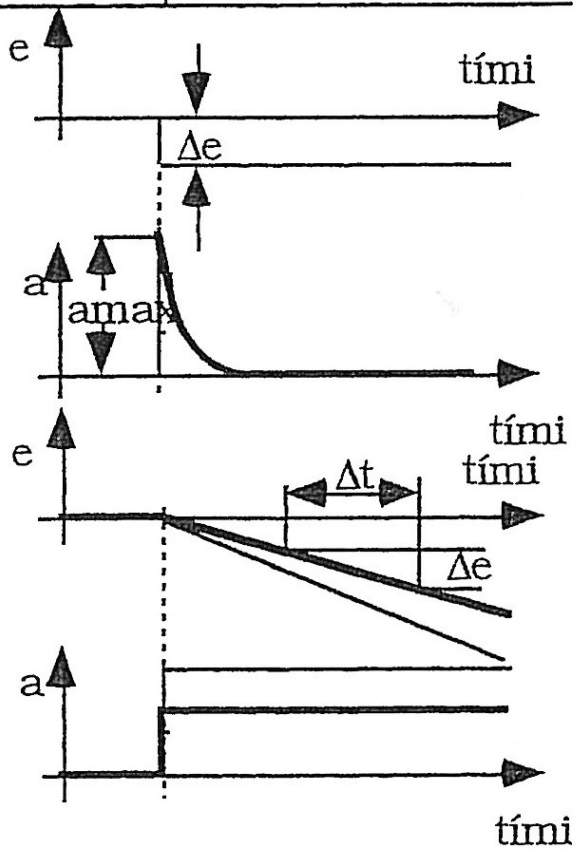
Lýsing	Tengimynd	Þrepsvar/Hallasvar

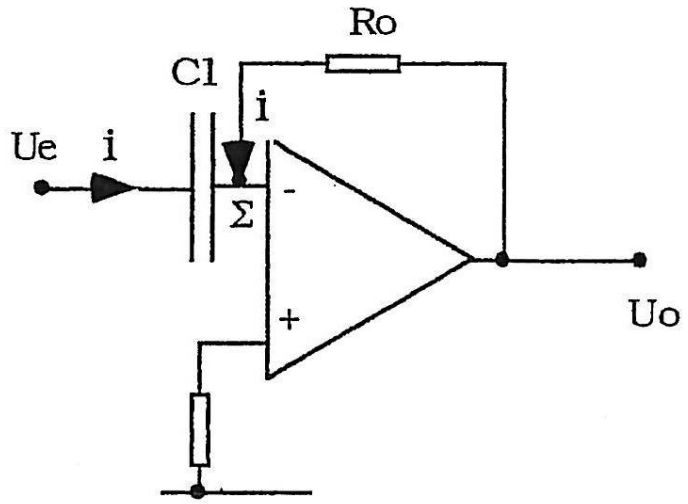
Þrepsvar:
Öflugt svar kemur í upphafi þrepsins en síðan deyr það út.

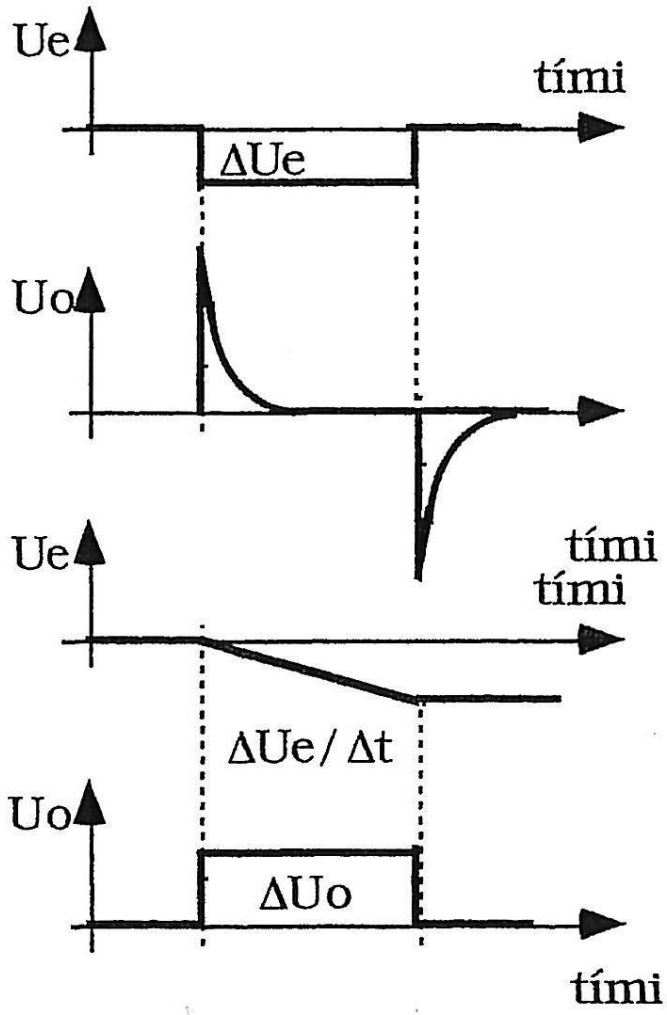
Hallasvar:
Svarritið er þrep og stendur stærð þrepsins í réttu hlutfalli við stærðina $\Delta e/\Delta t$, þ.e. hraðann á breytingu aðmerkisins e. Stærð þrepsvarsins er einnig háð töfinni í bakafærslunni sem ákvarðast af tíma-stuðlinum τd. Því meiri töf því stærra þrep.



$$a = \pm \tau d \cdot \frac{de}{dt};$$




Ro
Cl
i
Ue
i
Σ
-
+
Uo

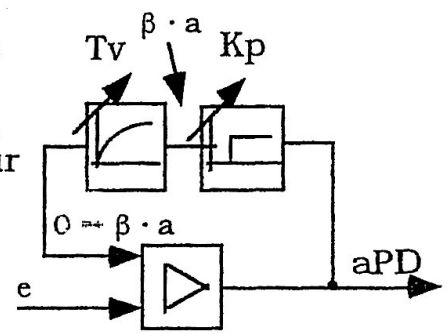

Ue
tími
ΔUe
Uo
Ue
tími
tími
ΔUe/Δt
Uo
ΔUo
tími

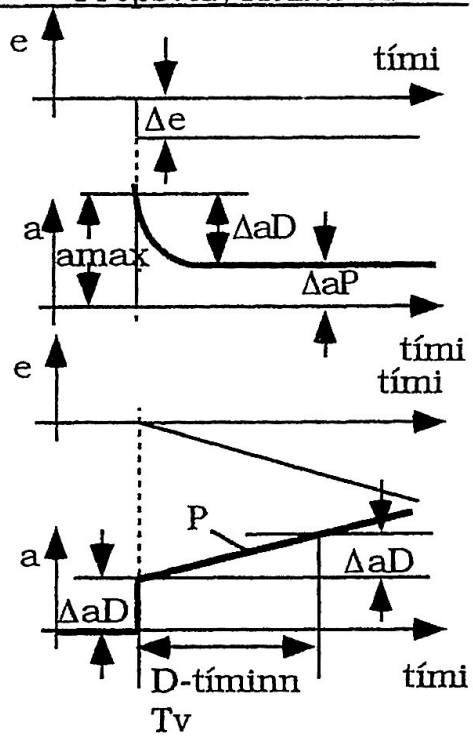
PD stilling

Lýsing	Tengimynd	Þrepsvar/Hallasvar

<u>Viðbrögð við þrepsvari</u>
Fyrst kemur hið öfluga merki vegna D-eiginleikans og um leið hið hlutfallslega merki vegna P-eiginleikans, en það síðastnefnda stendur áfram.

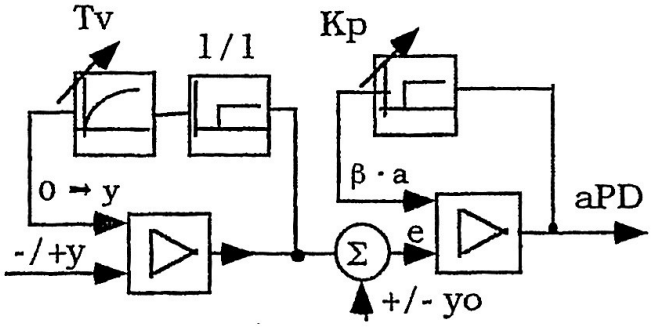
<u>Viðbrögð við hallariti</u>
Fyrst kemur þrepið ΔaD sem er D-eiginleikinn og stækkar með halla innmerkisins. Síðan kemur P-þátturinn sem endurspeglar halla innmerkisins.
D- tíminn Tv er skilgreindur út frá hallaritinu og er sá tími sem líður frá upphafi svörunar þar til tillegg P-þáttarins til útmerkisins a er orðið það sama og D-þátturinn olli í upphafi.



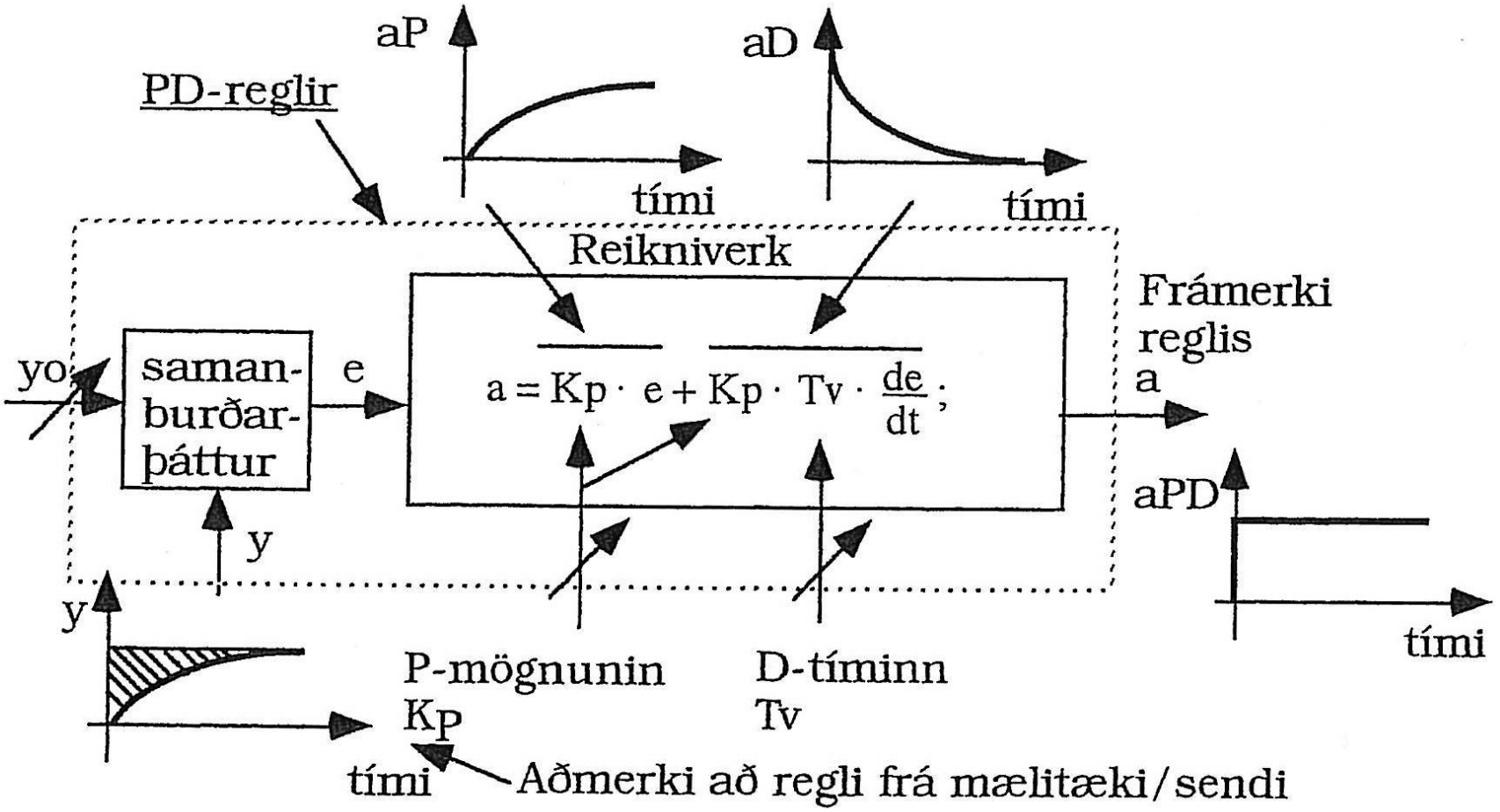


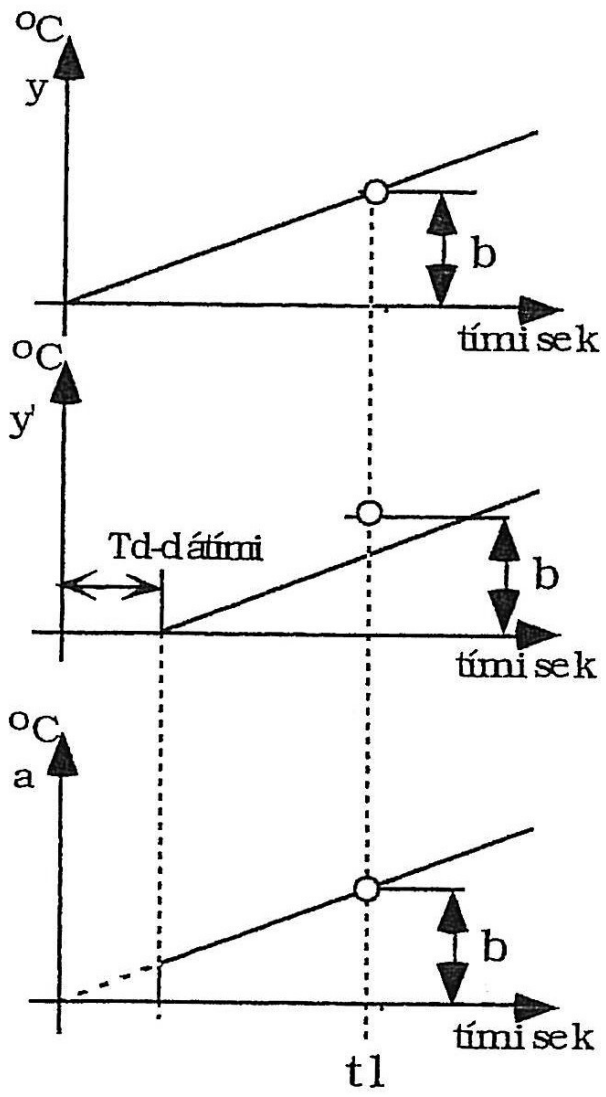
$$aPD = Kp \cdot e + Kp \cdot Tv \cdot \frac{de}{dt};$$

<u>Bakafærsla með stýranlegum styrkleika og töf.</u>
Hafa má áhrif á þrepið ΔaD með töfinni Tv (D-tíminn).
P- mögnunin ræðst af styrkleika bakafærslunnar Kp.



<u>Neðri tengimyndin</u> sýnir annað fyrirkomulag en þar er sett í aðmerkið y tímabundin formögnun innmerkisins.

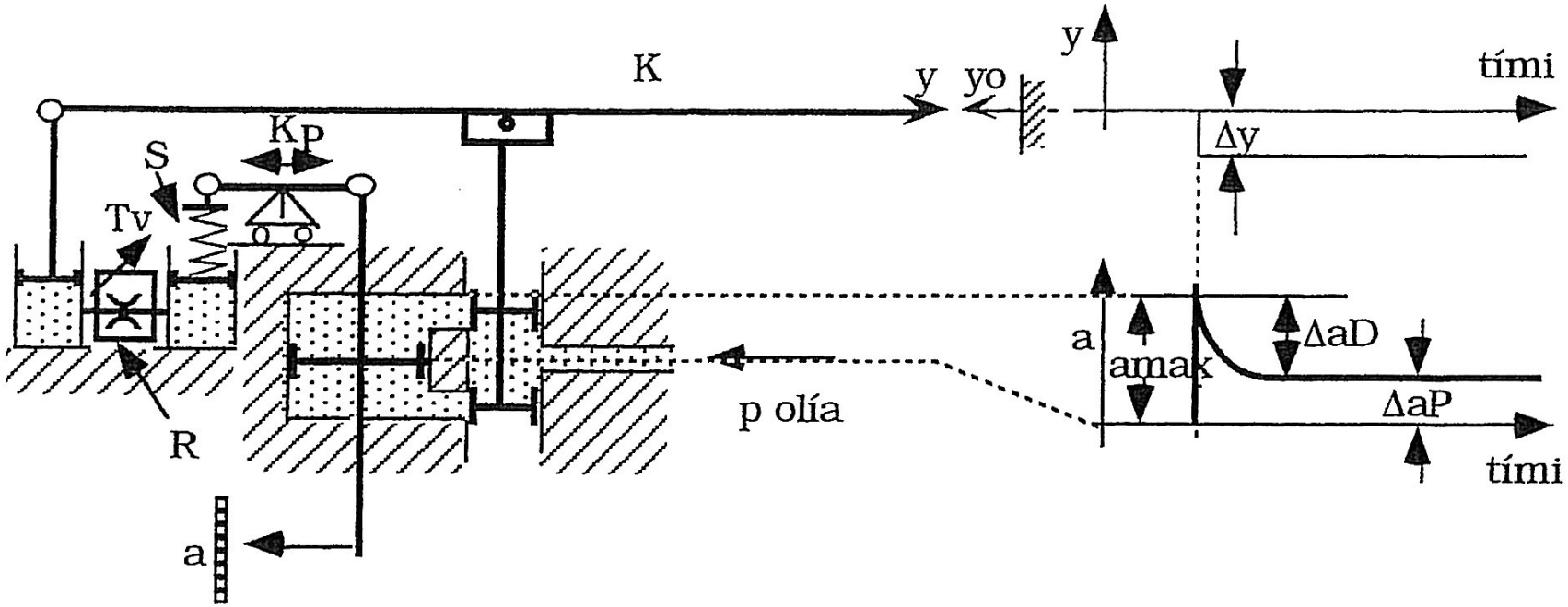

aP
aD
PD-reglir
tími
tími
Reikniverk
Frámerki
reglis
a
yo
saman-
burðar-
þáttur
e
$a = Kp \cdot e + Kp \cdot Tv \cdot \frac{de}{dt}$;
aPD
y
y
tími
P-mögnunin
Kp
D-tíminn
Tv
tími
Aðmerki að regli frá mælitæki/sendi

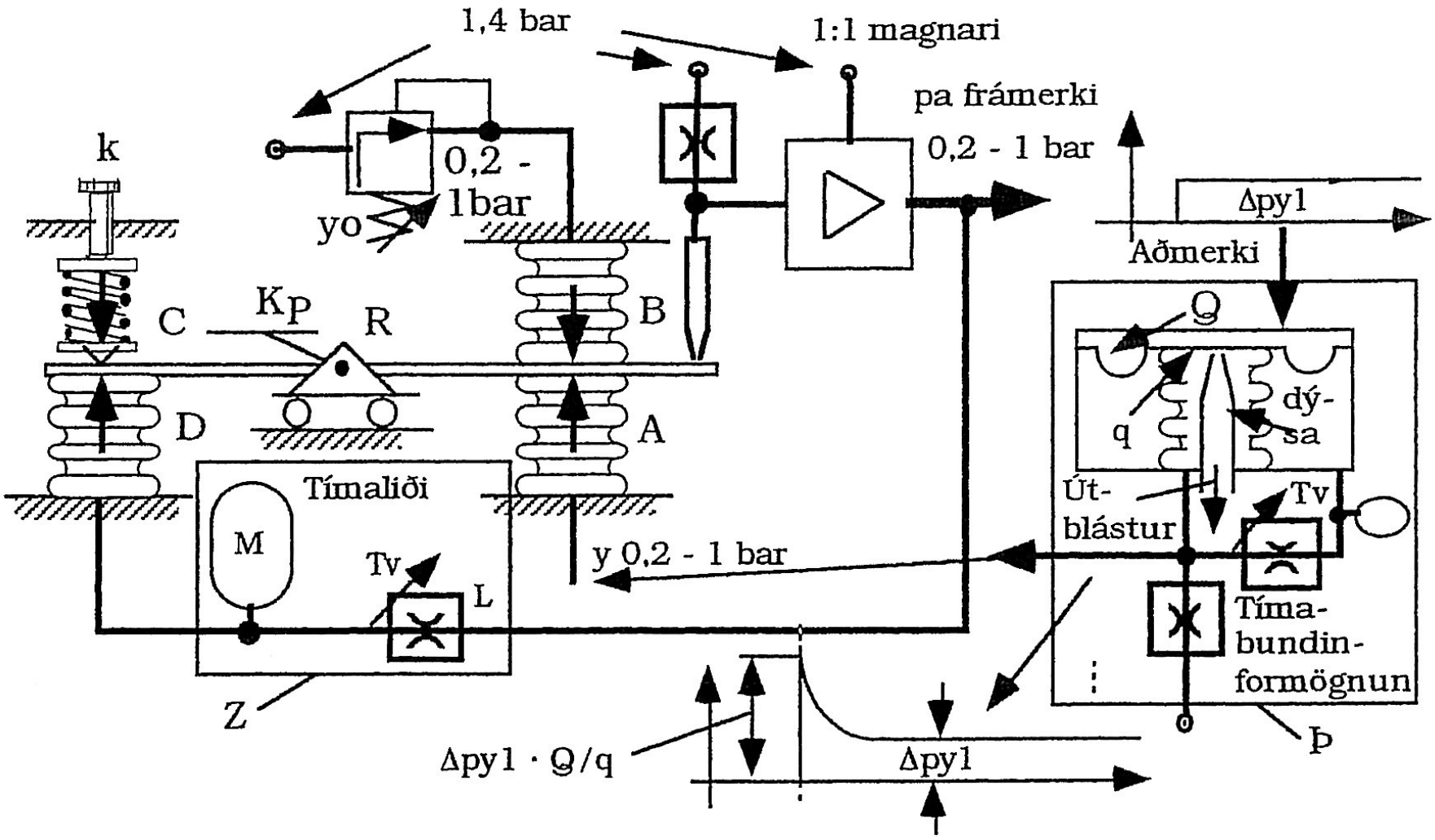


Raunverulegt aðmerki.

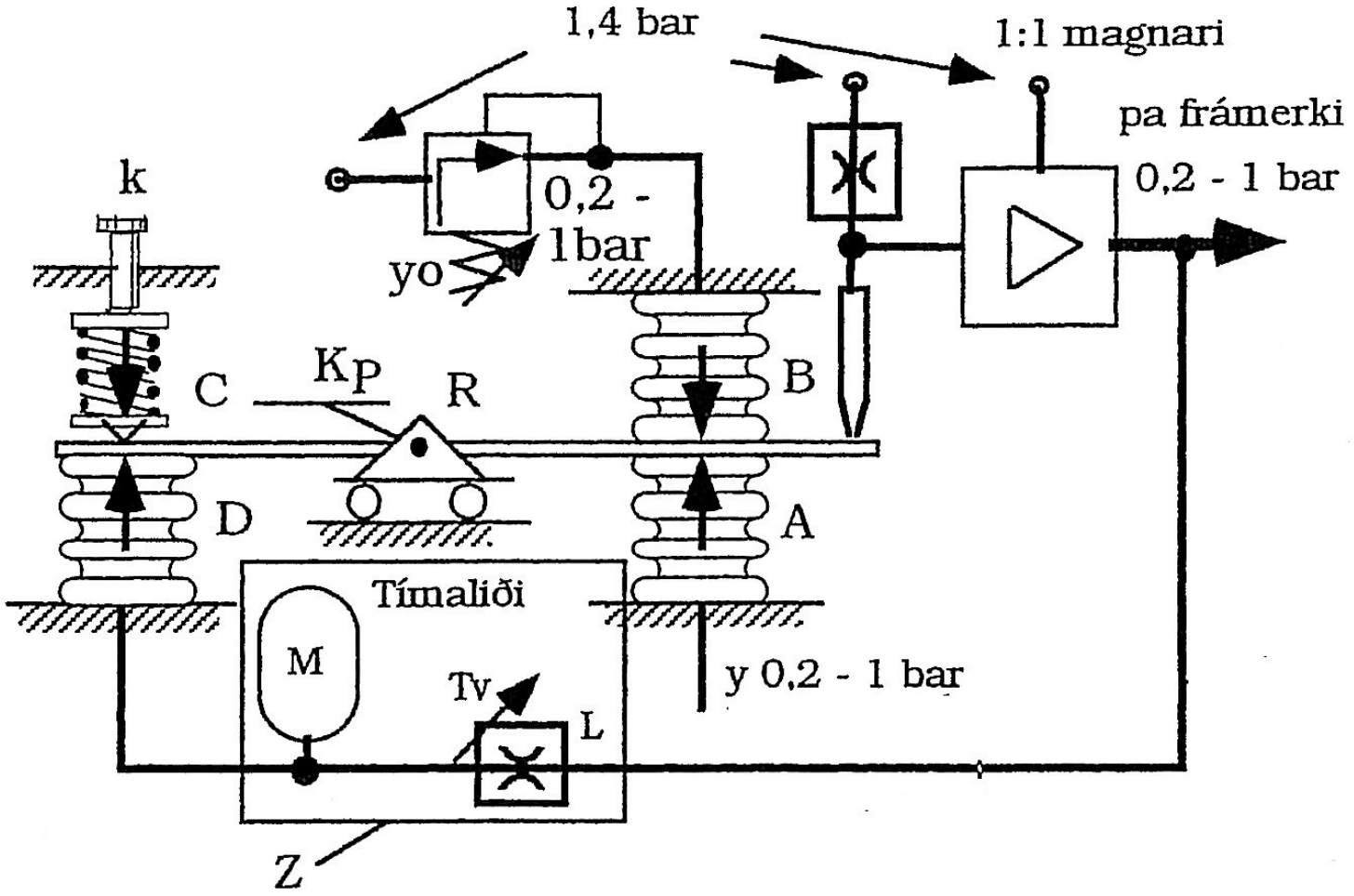
Merki eftir skynjara þar sem ákveðinn dátími Td er til staðar.

Merkið eftir að það hefur orðið fyrir tímabundinni formögnun eða D-verkun.

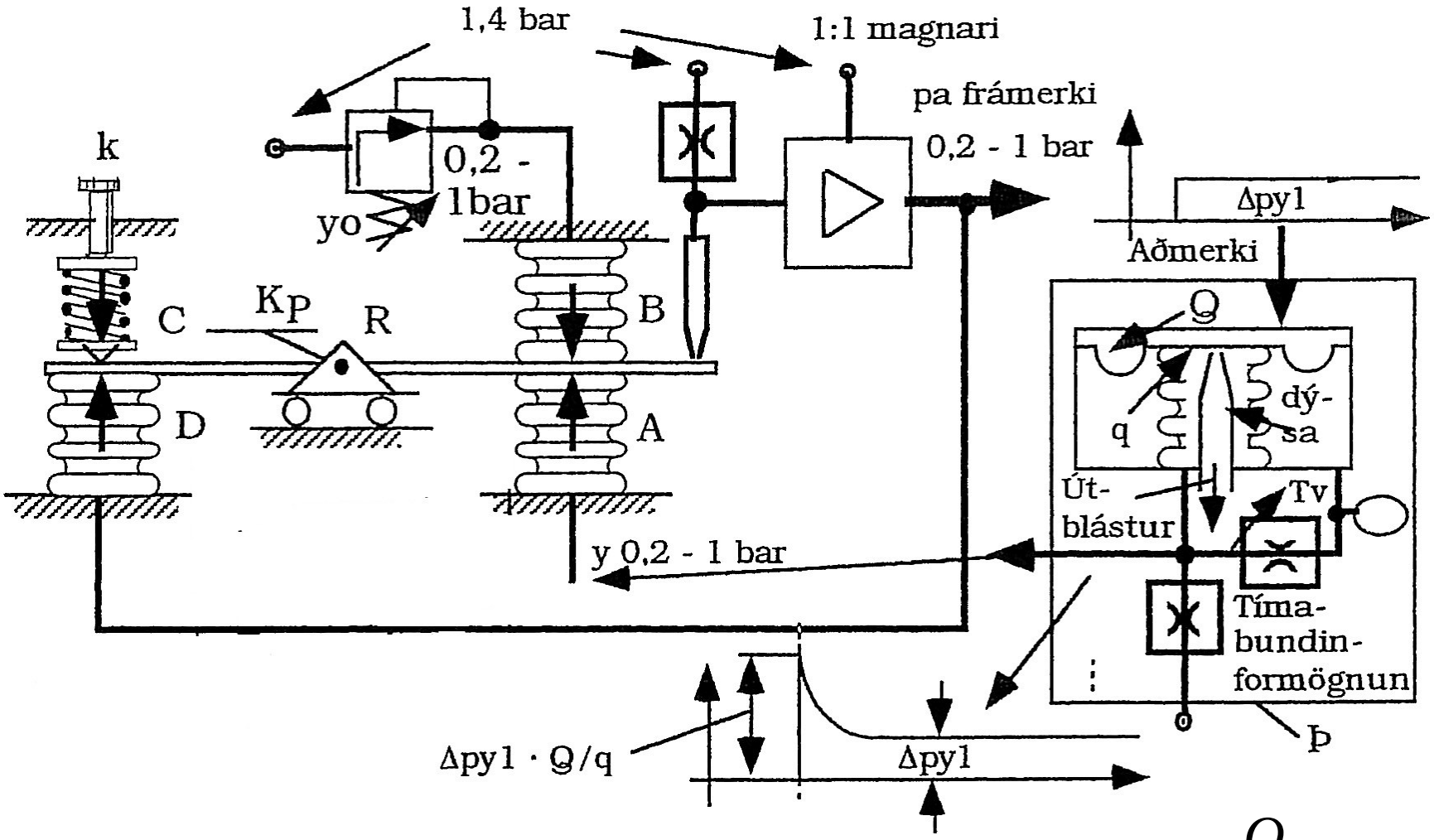

K
y
yo
y
tími
Δy
KP
S
Tv
R
a
p olía
a
amax
ΔaD
ΔaP
tími


1,4 bar
1:1 magnari
pa frámerki
0,2 - 1 bar
k
0,2 - 1bar
yo
Δpy1
Aðmerki
C
Kp
R
B
Q
D
A
q
dý-
sa
Útblástur
Tv
Tímaliði
M
Tv
L
y 0,2 - 1 bar
Tíma-
bundin-
formögnun
Z
Þ
Δpy1 · Q/q
Δpy1

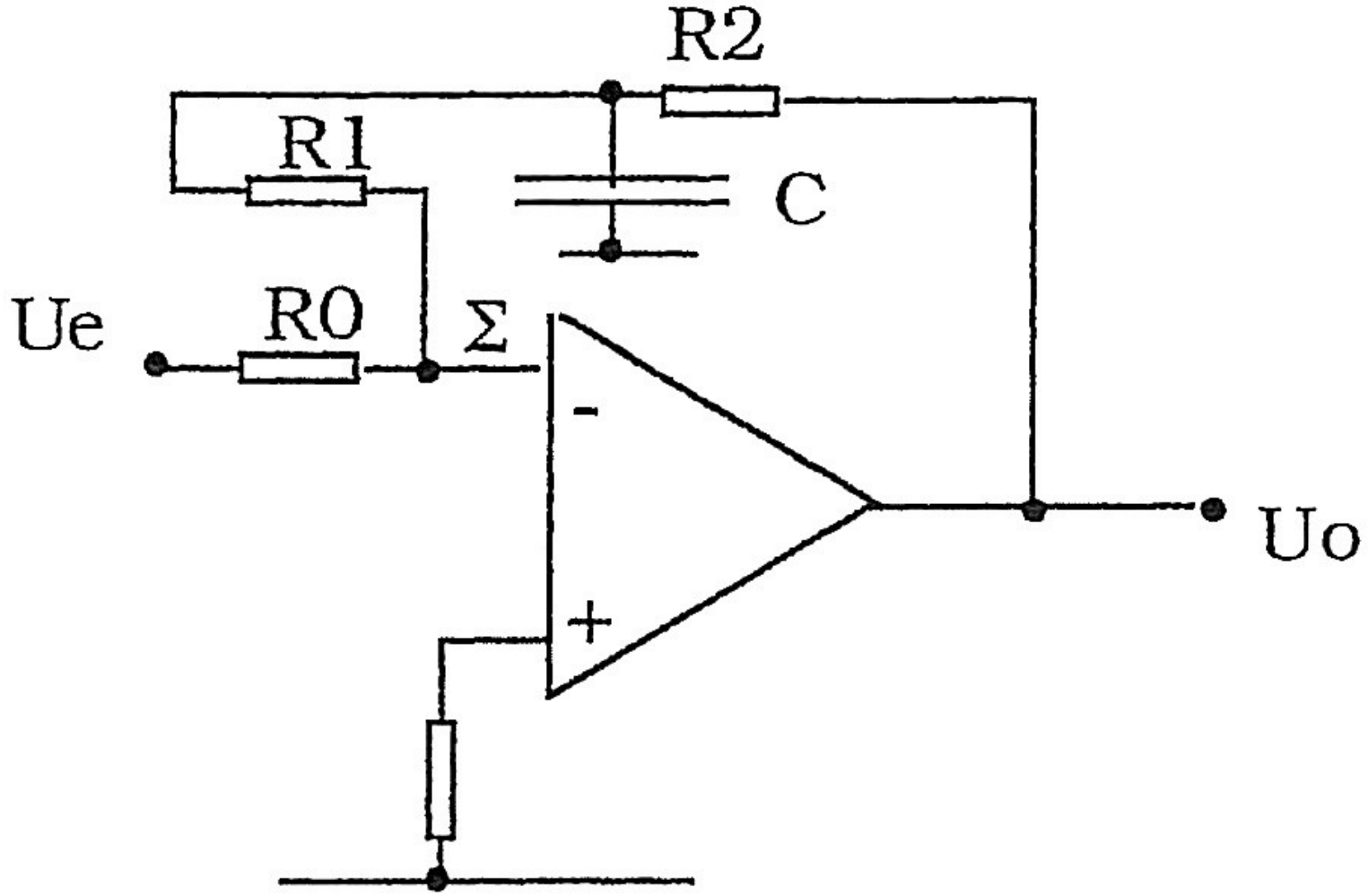
Töf á bakafærslu

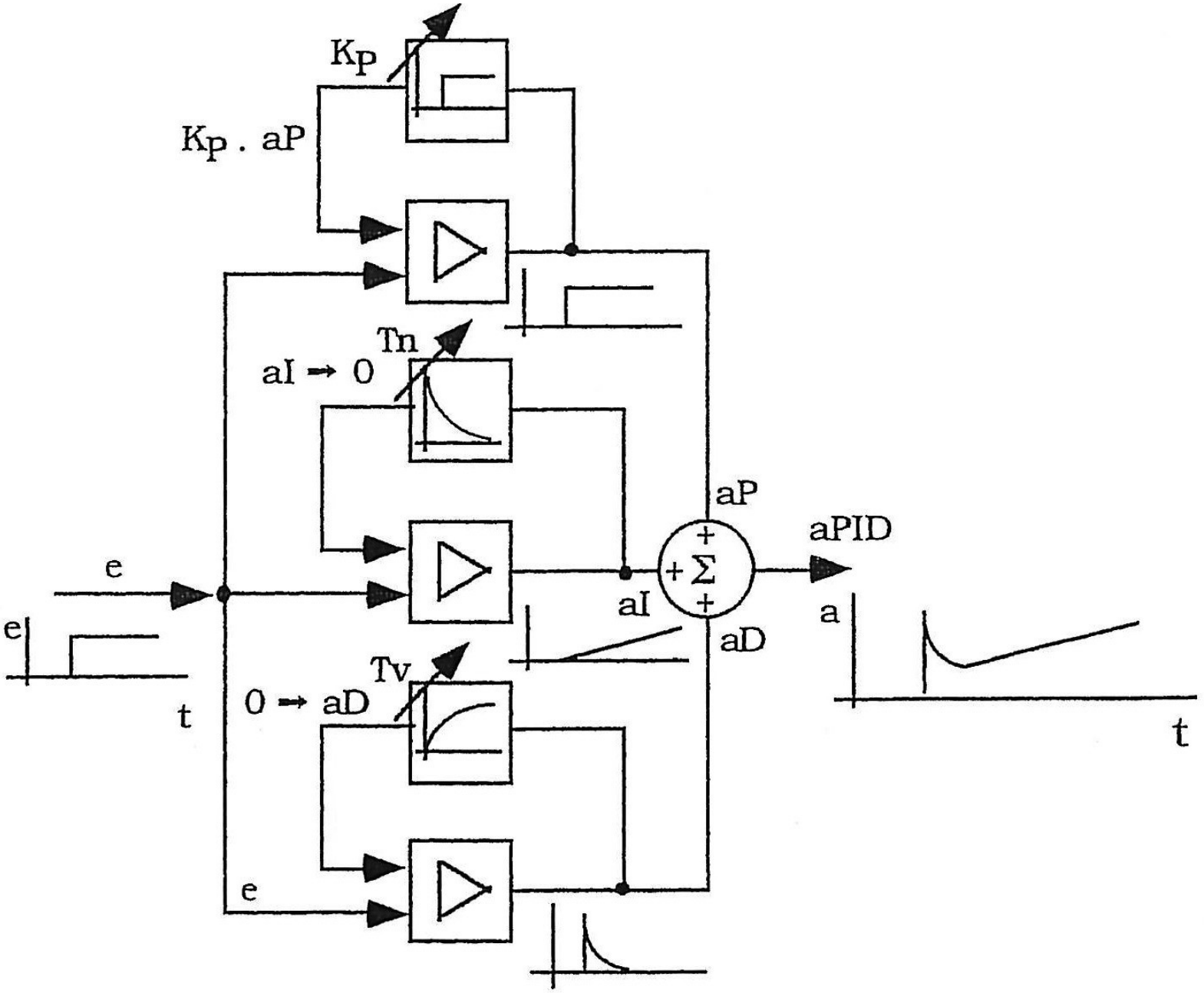


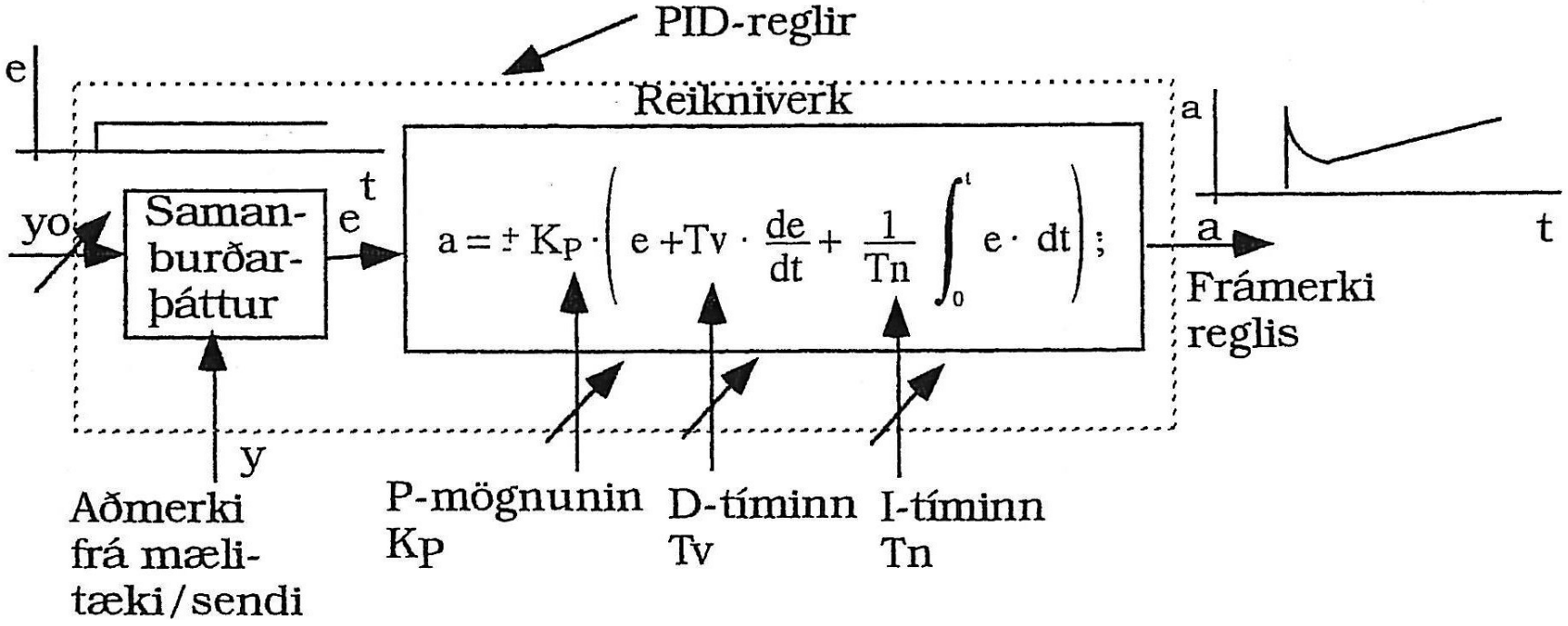
Mögnun á raungildi

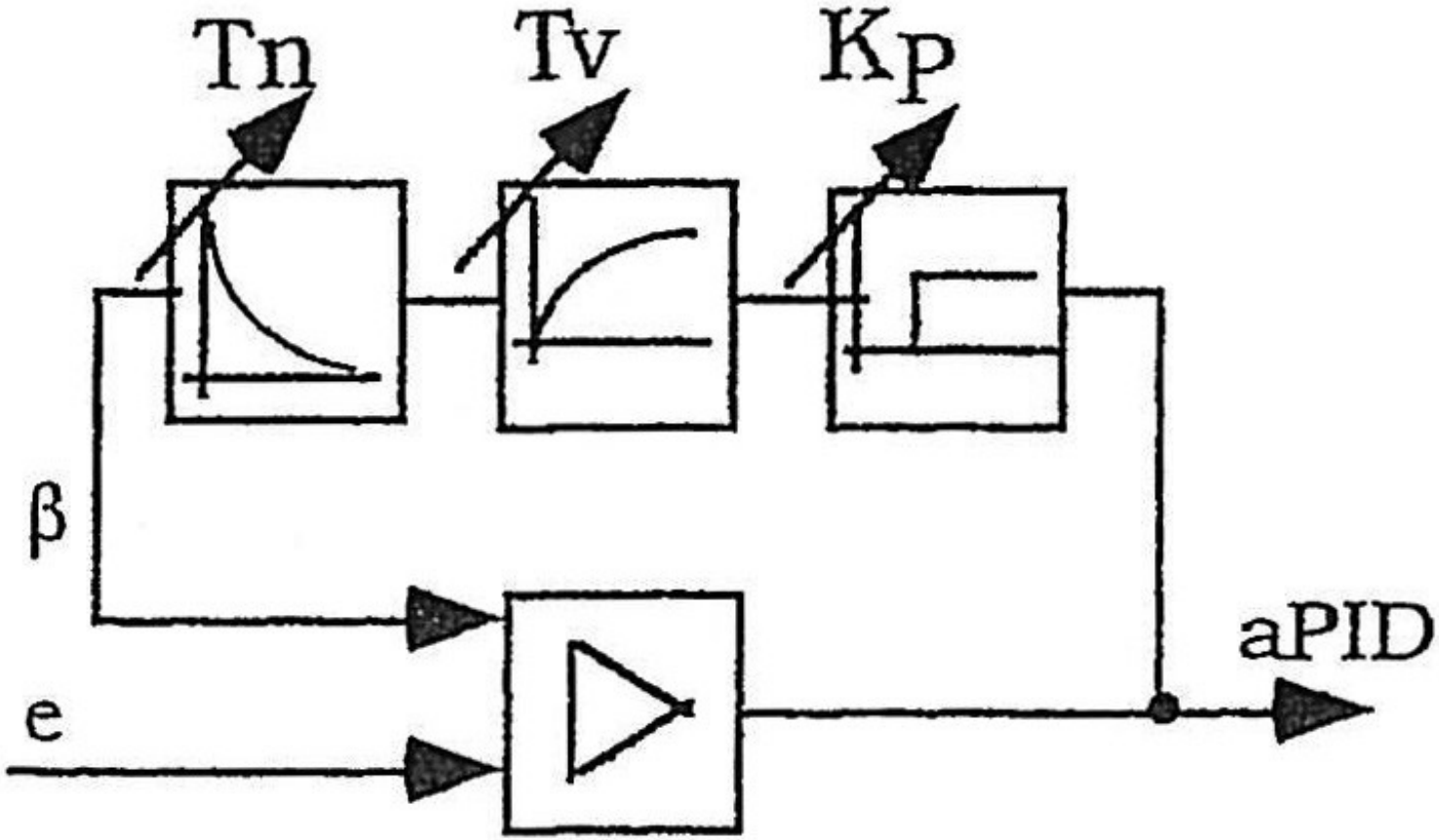


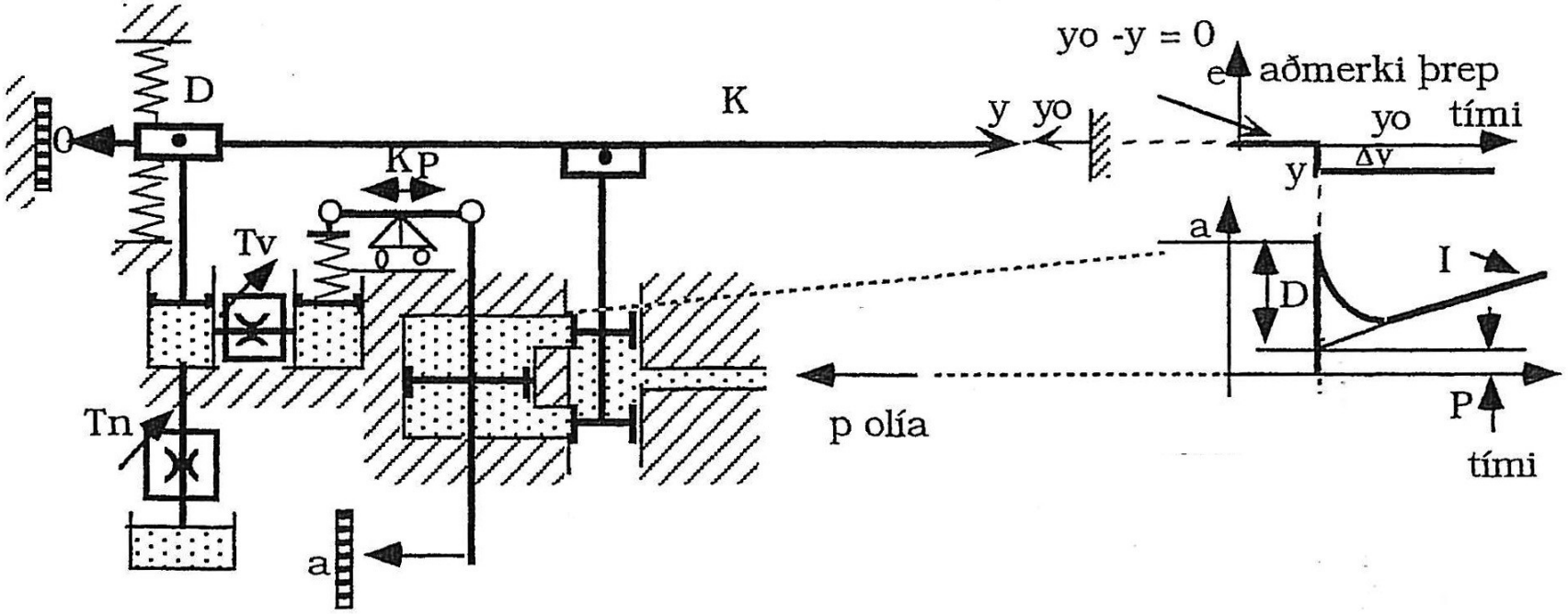
$$\Delta py_1 \cdot Q = \Delta p_{\max} \cdot q \quad \Rightarrow \quad \Delta p_{\max} = \Delta py_1 \cdot \frac{Q}{q}$$

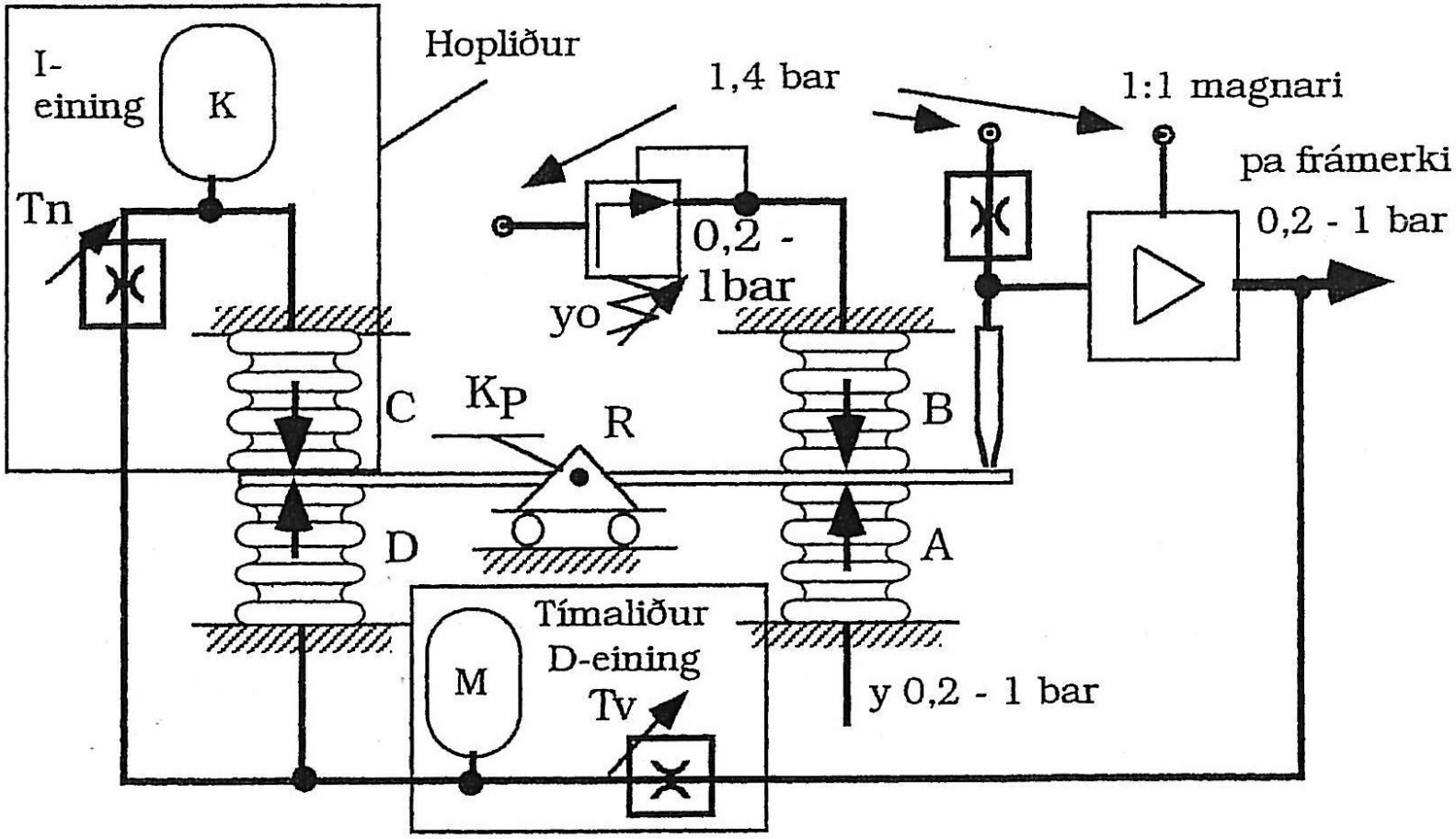

R2
R1
C
Ue
R0
Σ
-
+
Uo

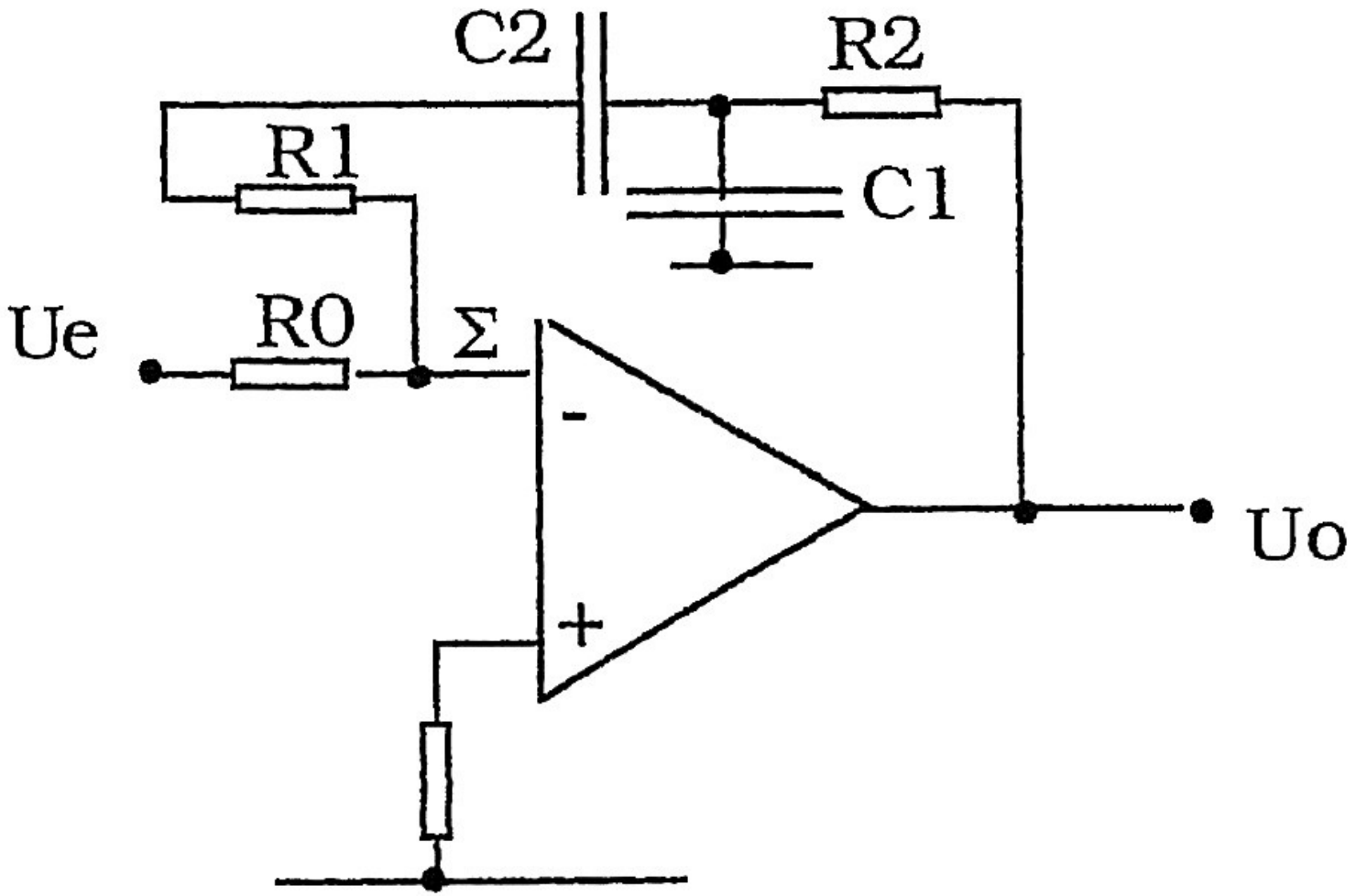

Kp
Kp . aP
Tn
aI → 0
aP
aPID
e
+
+ Σ
+
aI
aD
e
t
Tv
0 → aD
a
t
e


PID-reglir
Reikniverk
e
t
yo
Saman-
burðar-
þáttur
e
$a = \pm K_P \cdot \left(e + Tv \cdot \frac{de}{dt} + \frac{1}{Tn} \int_0^t e \cdot dt \right);$
a
t
a
Frámerki
reglis
y
Aðmerki
frá mæli-
tæki/sendi
P-mögnunin
K_P
D-tíminn
Tv
I-tíminn
Tn

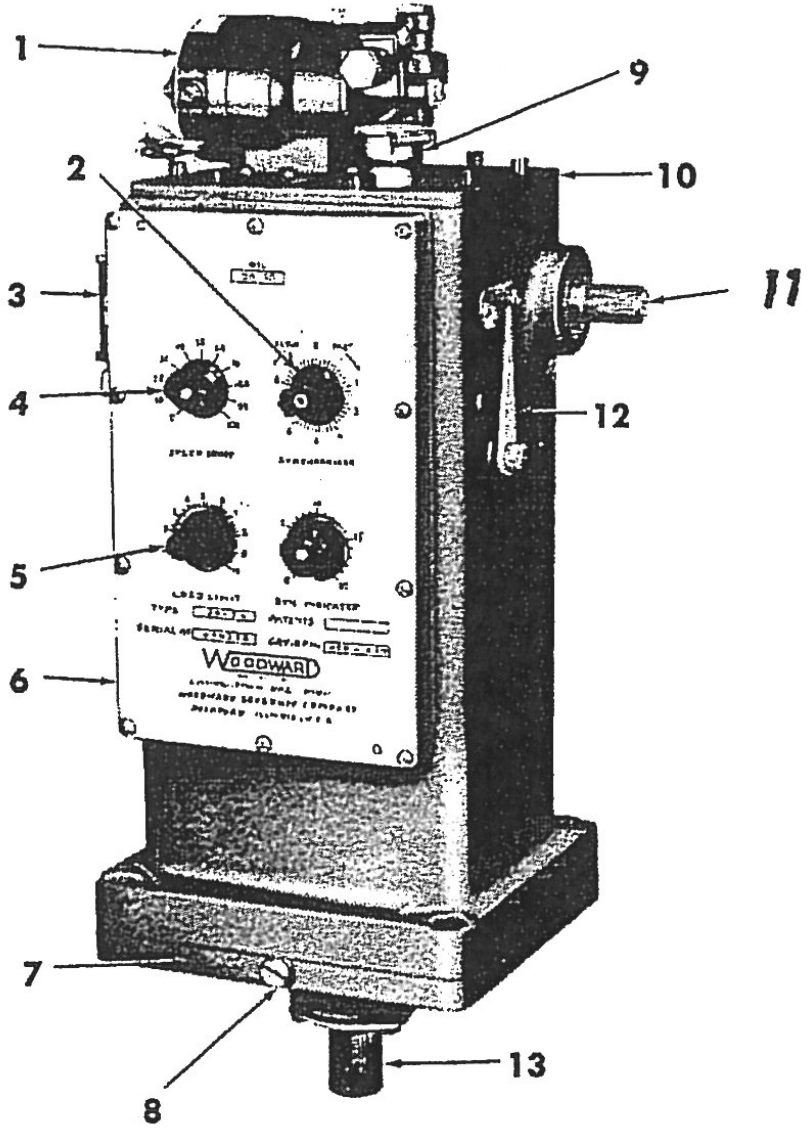

Tn
Tv
Kp
β
e
aPID


D
K
y yo
yo -y = 0
e
aðmerki þrep
yo tími
y
Δy
KP
Tv
a
D
I
Tn
p olía
P
tími
a

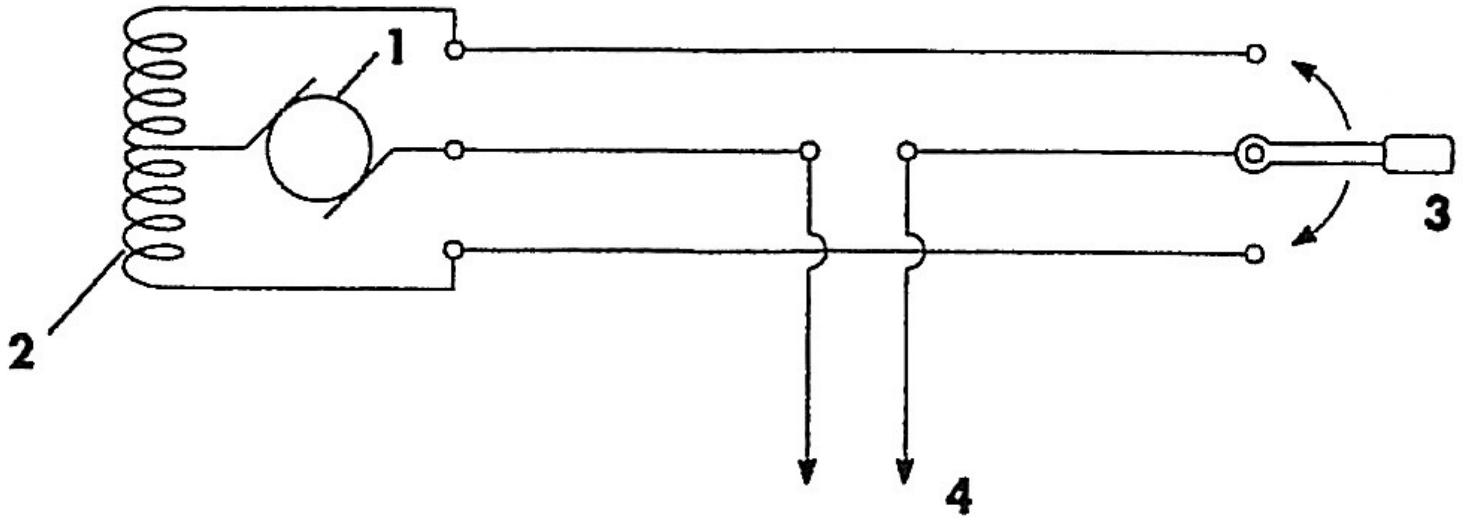

I-
eining
K
Tn
Hopliður
1,4 bar
1:1 magnari
pa frámerki
0,2 - 1 bar
0,2 -
1 bar
yo
C
KP
R
B
D
A
Tímaliður
D-eining
M
Tv
y 0,2 - 1 bar

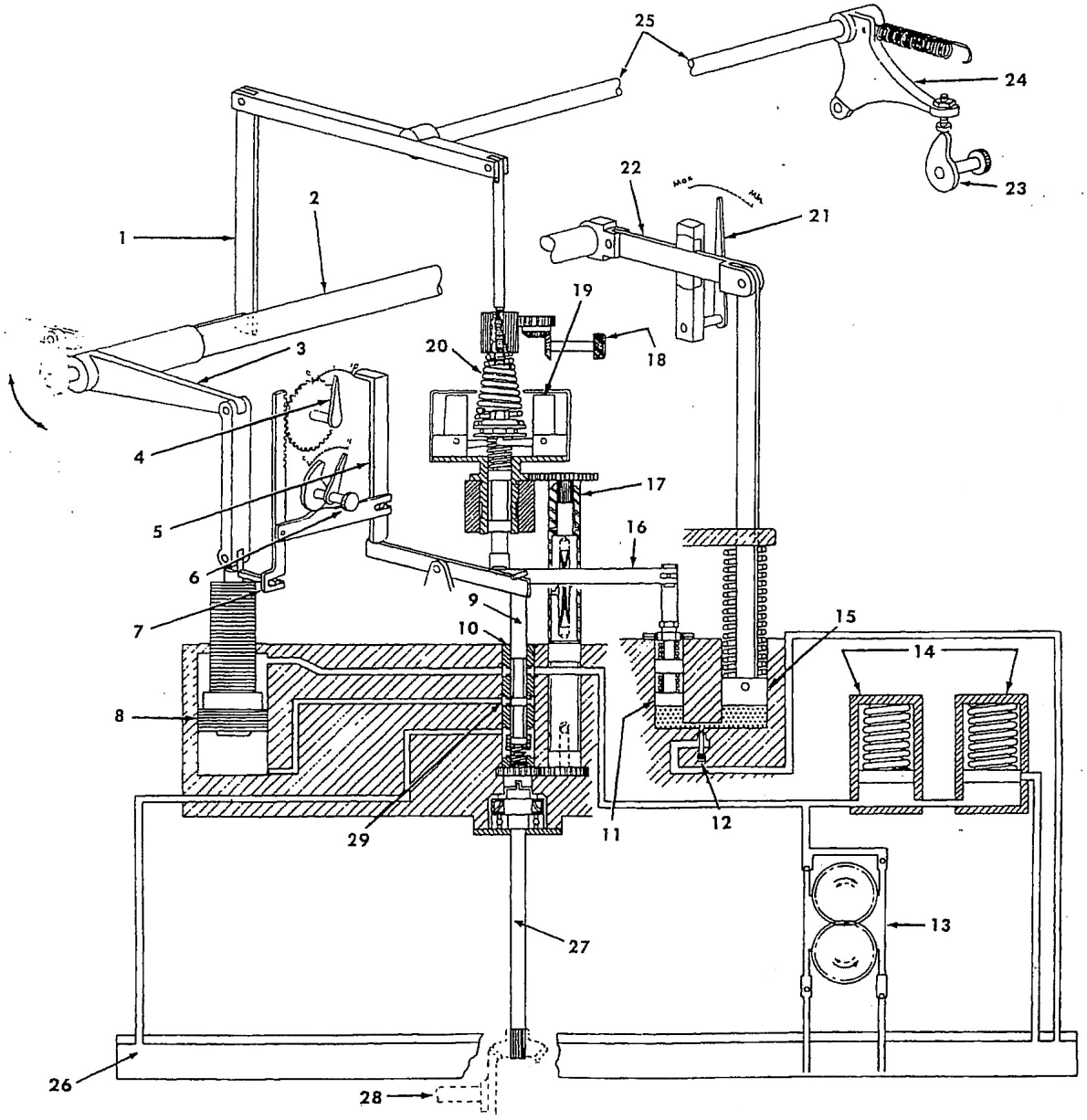

C2
R2
R1
C1
Ue
R0
Σ
-
+
Uo

Woodward UG
Þrýstivökvareglir

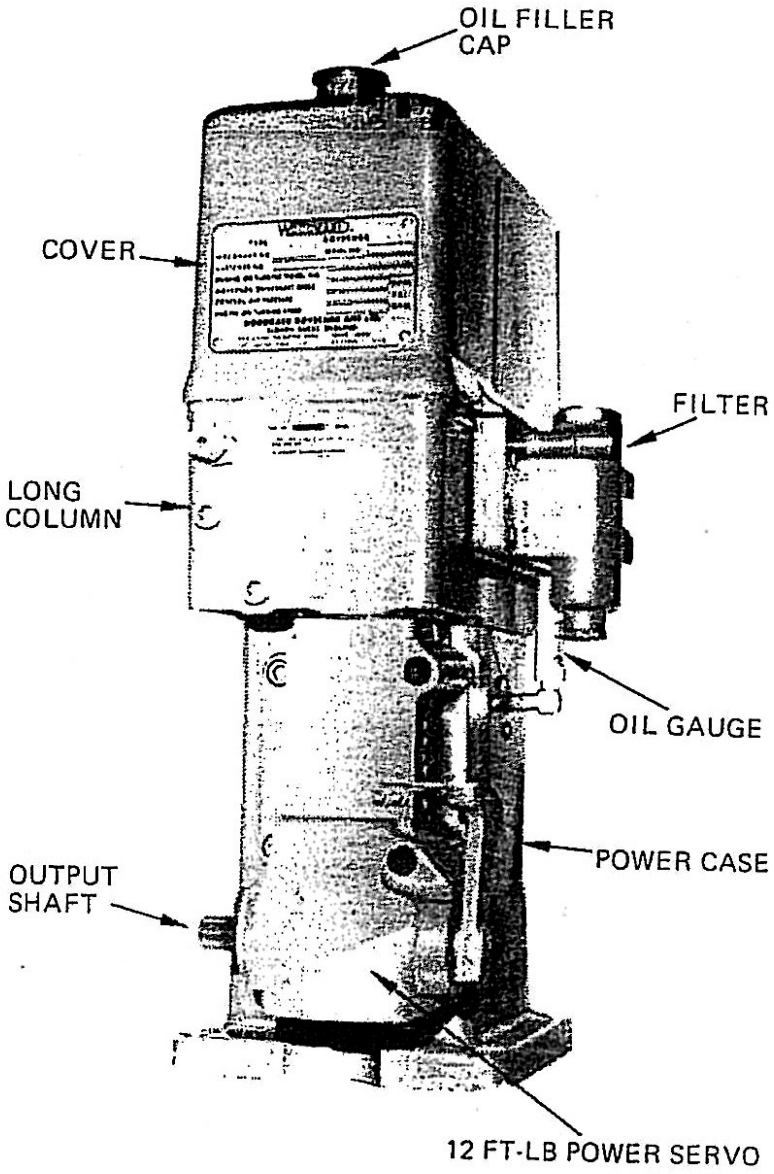


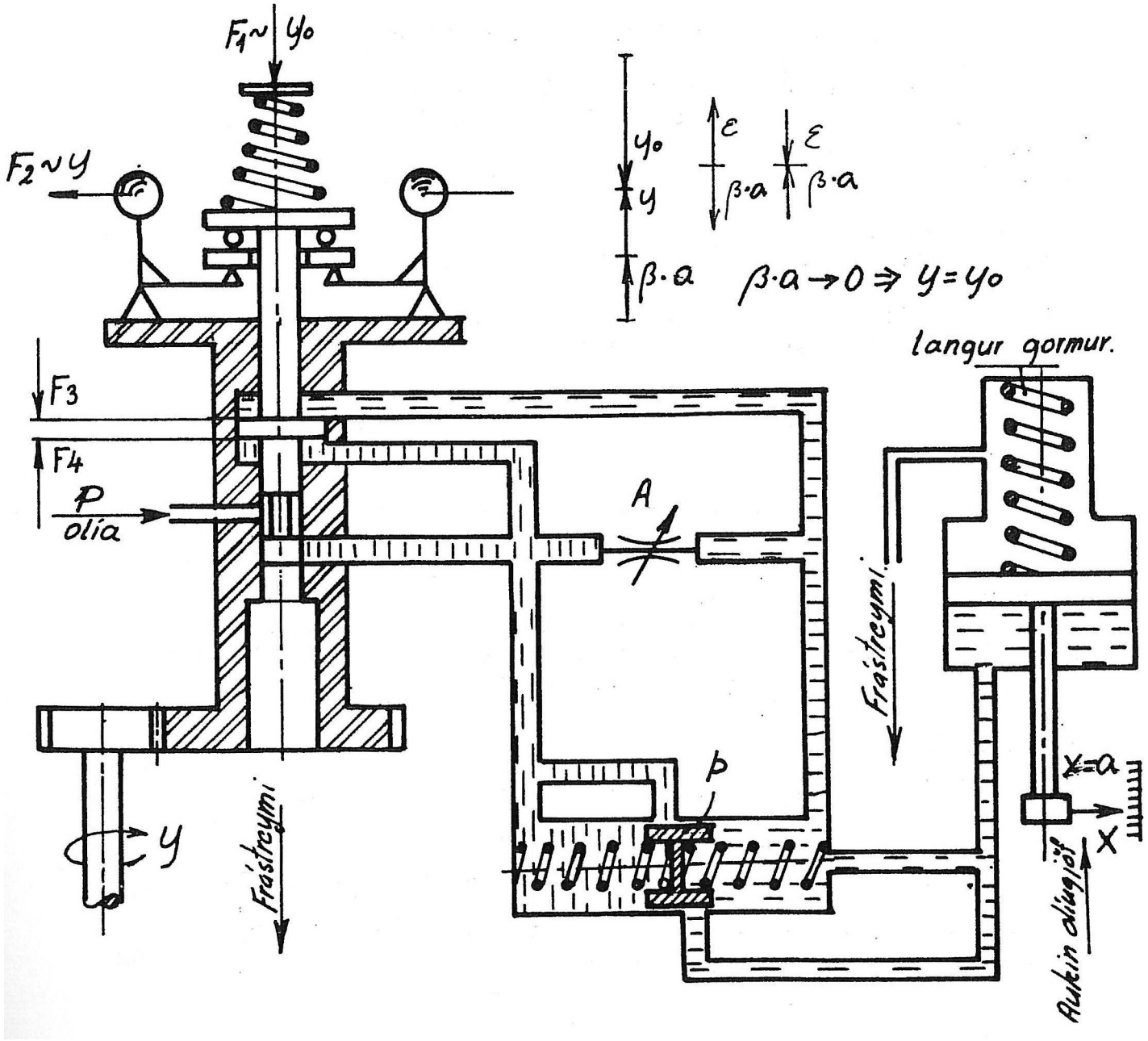
Óskgildis innsetning.

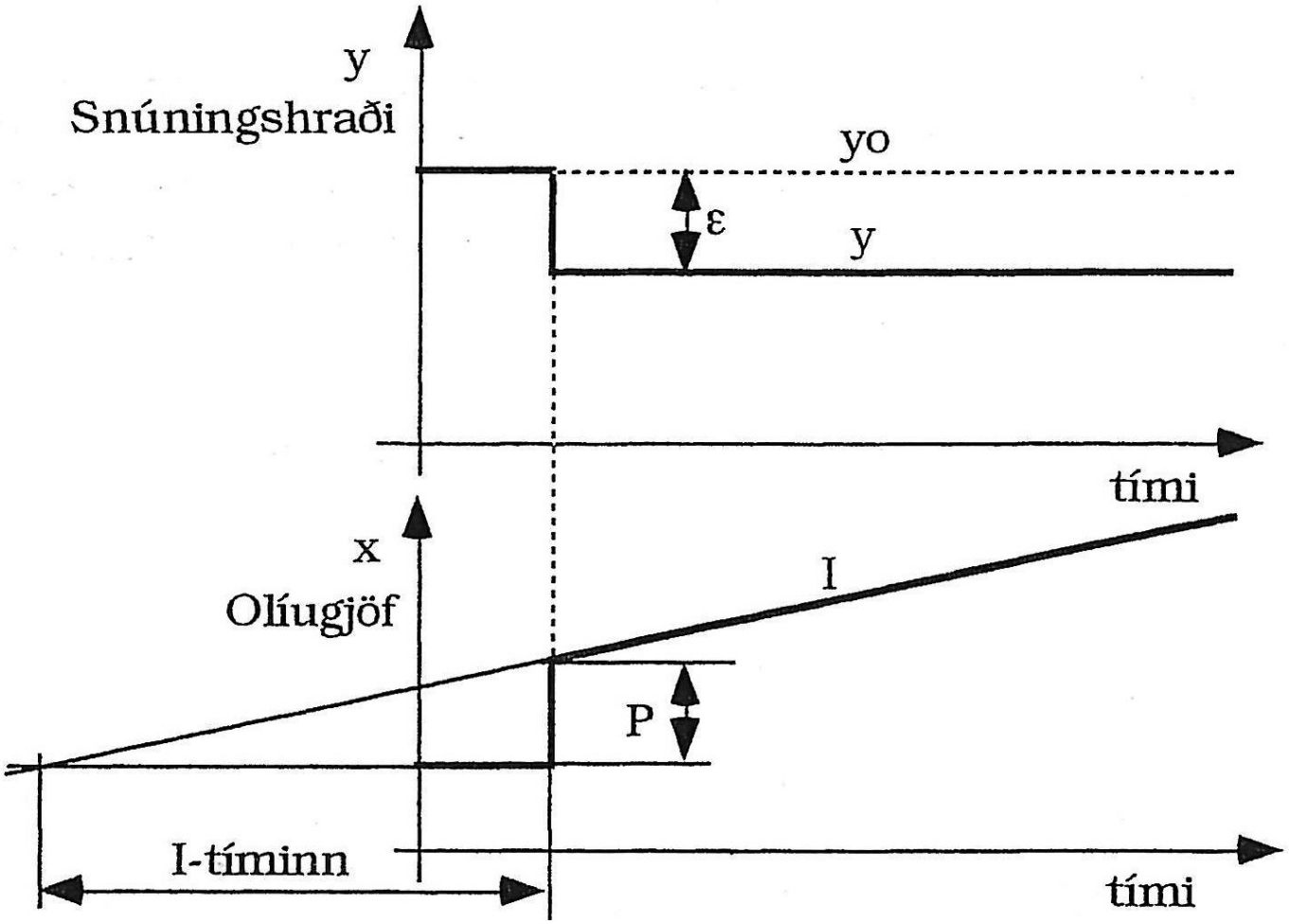



25
24
23
22
21
2
1
19
18
20
3
4
5
17
16
6
9
7
10
15
14
8
12
11
29
13
27
26
28

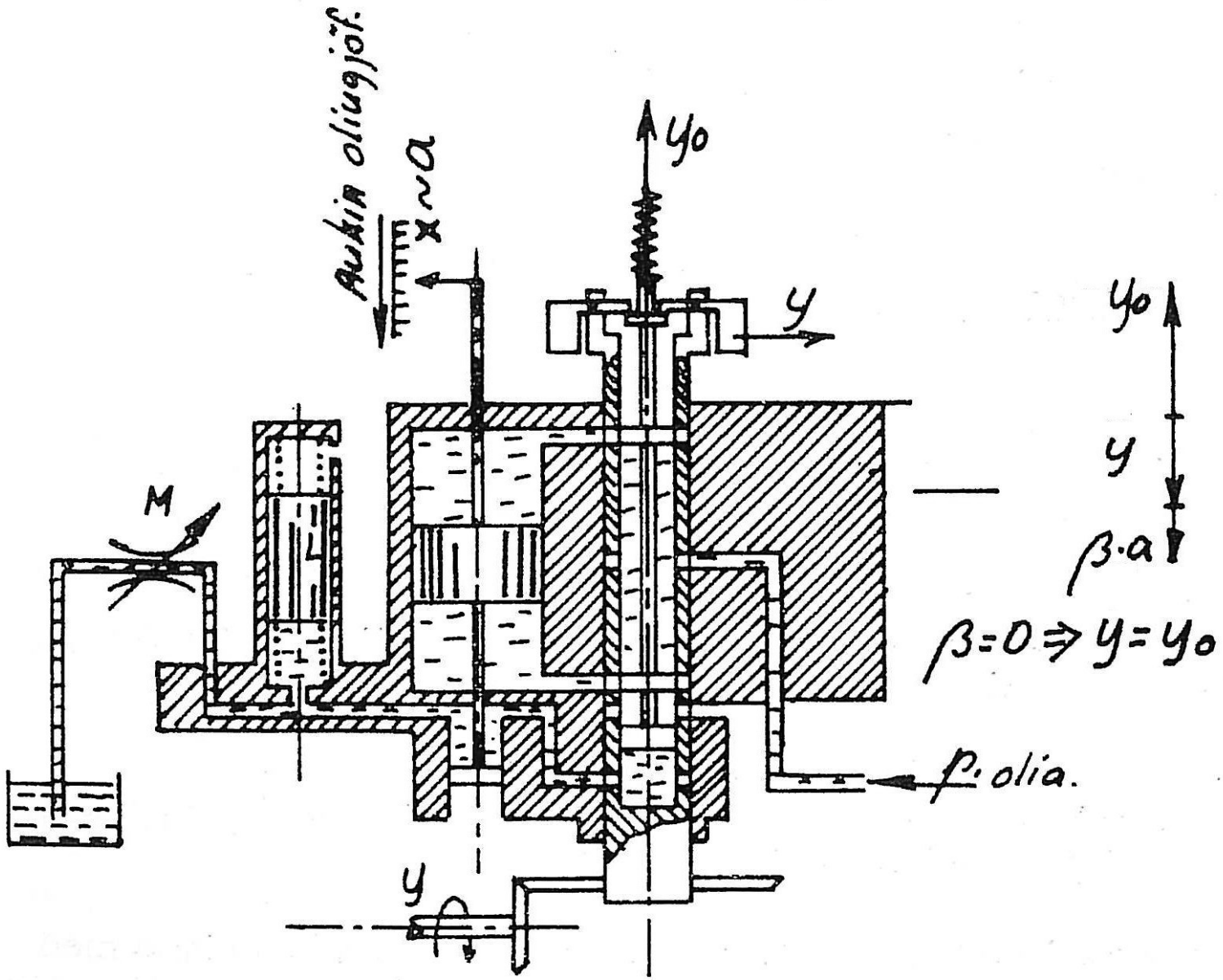
Woodward PG

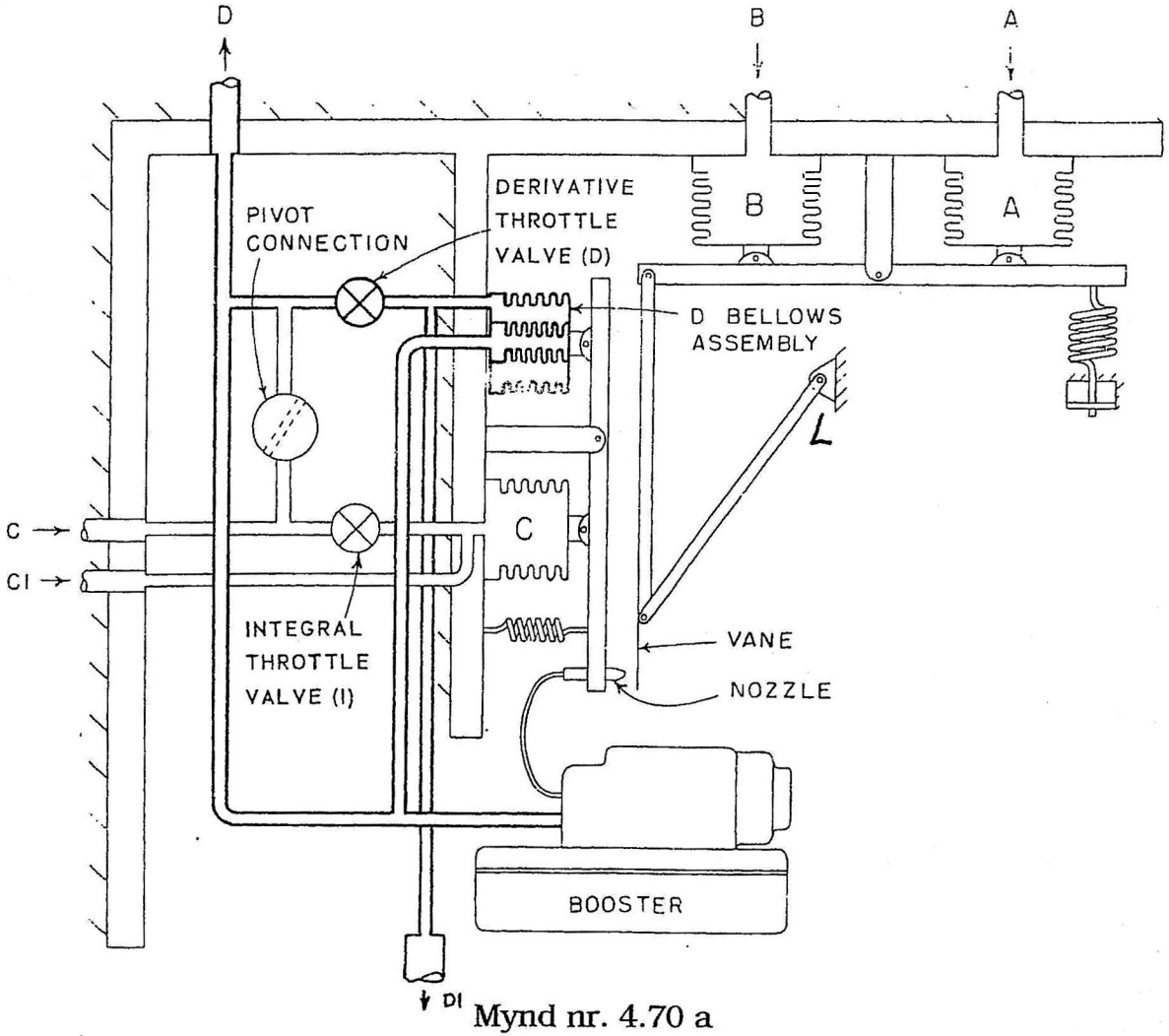

OIL FILLER CAP
COVER
FILTER
LONG COLUMN
OIL GAUGE
POWER CASE
OUTPUT SHAFT
12 FT-LB POWER SERVO


F1~y0
F2~y
F3
F4
P
olía
A
b
y
Frástreymi
Frástreymi
langur gormur.
x=a
x
Auka-olíugöt
y0
y
ε
β·a
ε
β·a
β·a
β·a→0 ⇒ y=y0

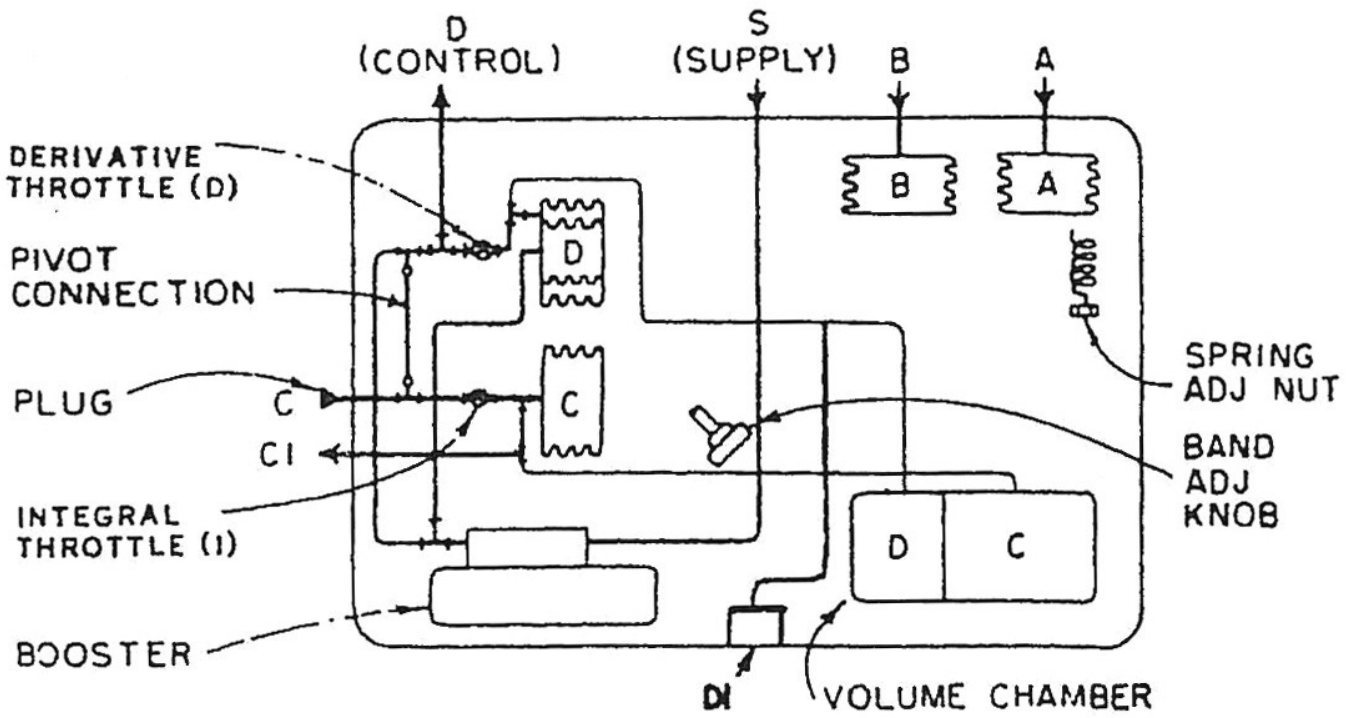

y
Snúningshraði
yo
ε
y
tími
x
Olíugjöf
I
P
I-tíminn
tími

Europa EHP

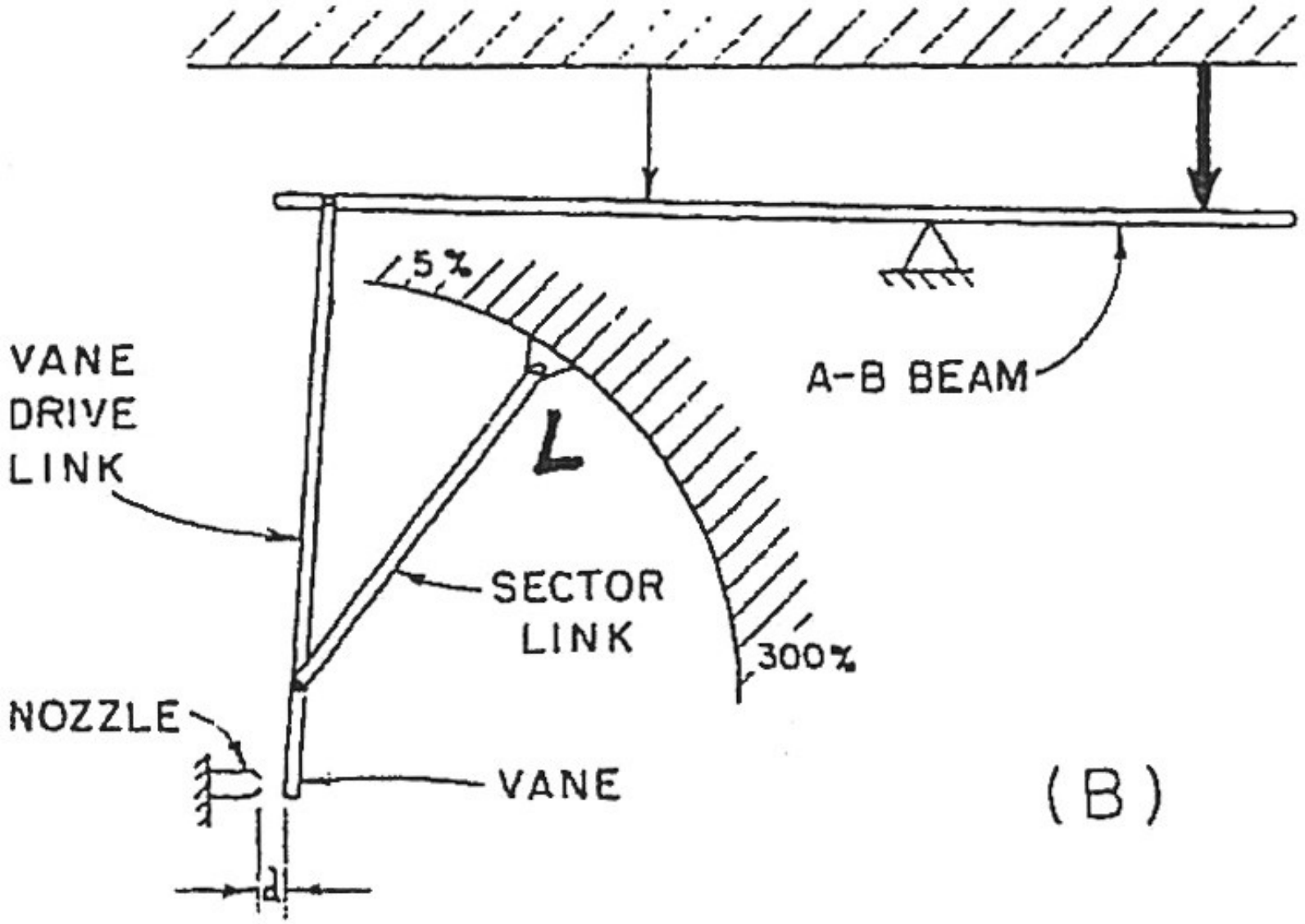

Aukin oliugjöf.
x ~ a
y_0
y
M
y_0
y
$\beta \cdot a$
$\beta = 0 \Rightarrow y = y_0$
P. olia.
y

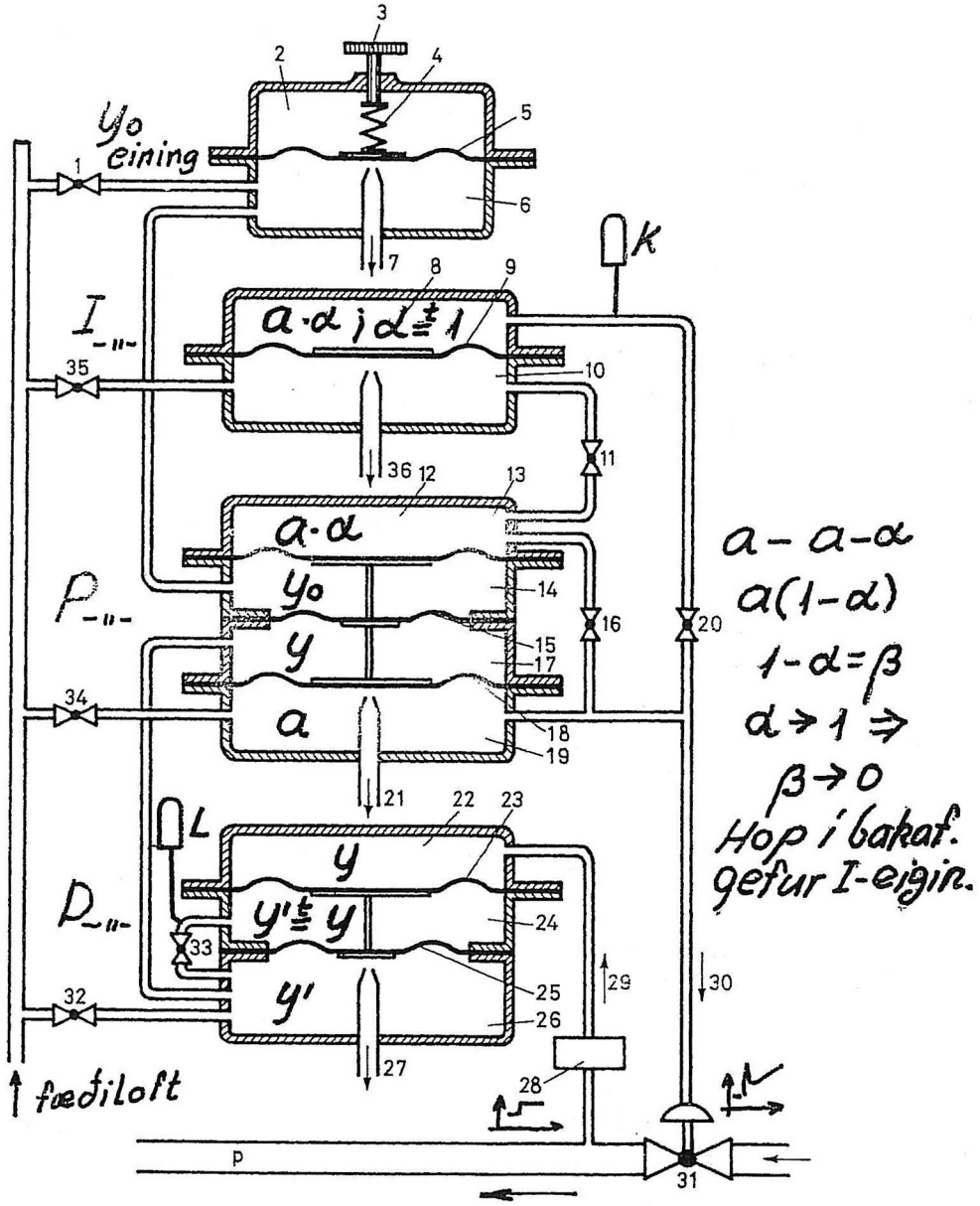

D
B
A
PIVOT
CONNECTION
DERIVATIVE
THROTTLE
VALVE (D)
B
A
D BELLOWS
ASSEMBLY
L
C
C
CI
C
INTEGRAL
THROTTLE
VALVE (I)
VANE
NOZZLE
BOOSTER
DI

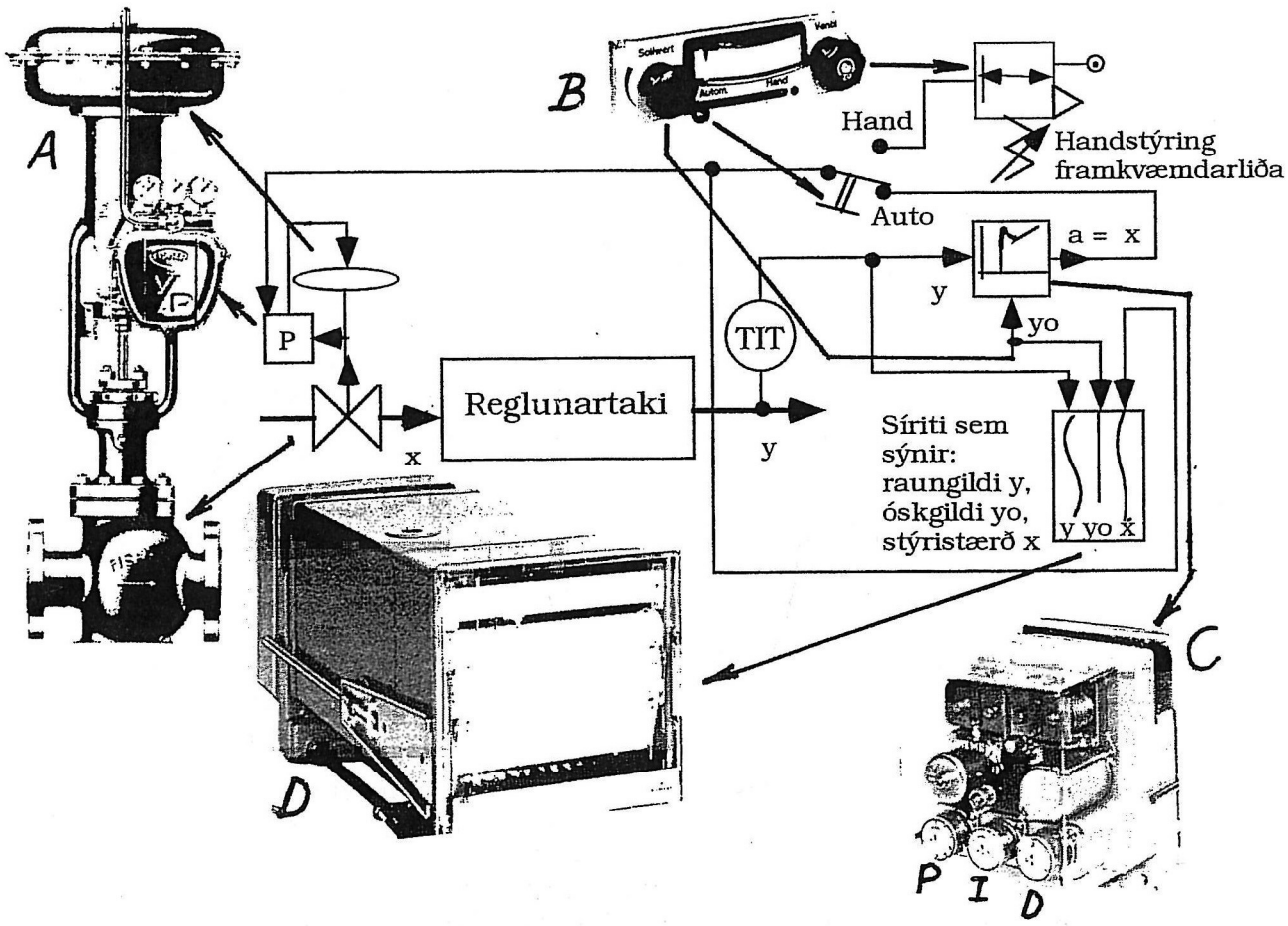
Mynd nr. 4.70 a

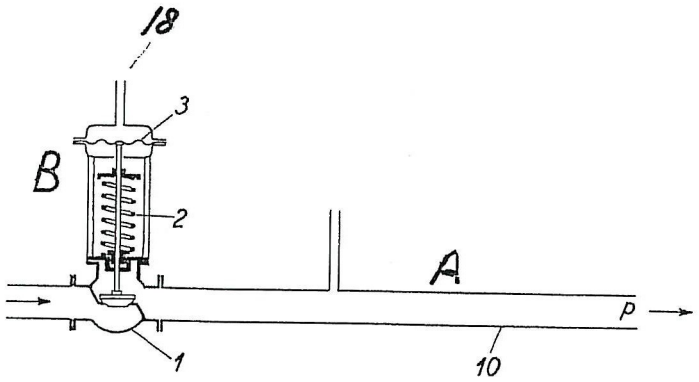


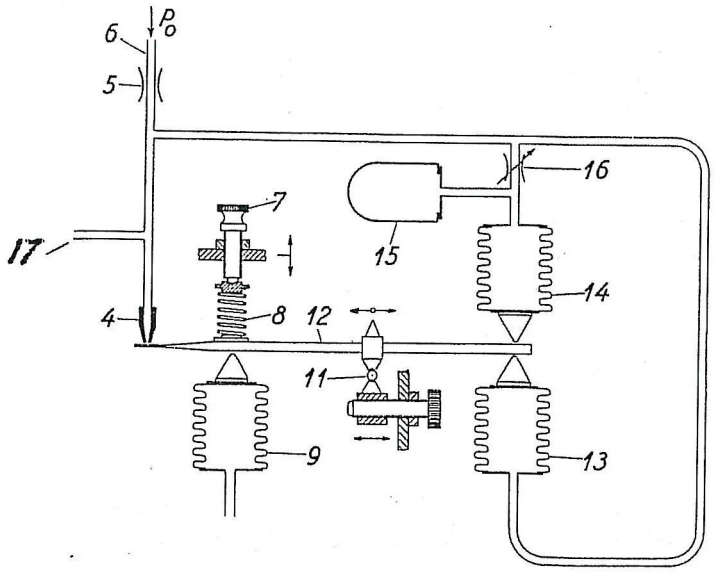
STANDARDIZING RELAY
(WITH PROPORTIONAL & INTEGRAL & DERIVATIVE ACTION)


5%
VANE
DRIVE
LINK
L
A-B BEAM
SECTOR
LINK
300%
NOZZLE
VANE
d
(B)


3
2
4
y_o eining
5
1
6
K
7
8
9
$I_{-"-}$
a·α ; α ≠ 1
35
10
11
36
12
13
a·α
$P_{-"-}$
y_o
14
16
20
y
15
17
34
a
18
19
21
22
23
L
y
$D_{-"-}$
y' ≠ y
24
33
25
29
30
32
y'
26
27
28
fæðiloft
p
31
a − a·α
a(1−α)
1−α=β
α→1 ⇒
β→0
Hop í bakaf.
gefur I-eigin.


A
B
C
D
P
TIT
Reglunartaki
x
y
Hand
Auto
Handstýring
framkvæmdarliða
a = x
y
yo
Síriti sem
sýnir:
raungildi y,
óskgildi yo,
stýristærð x
y yo x
P I D


18
3
B
2
A
P
1
10


P_o
6
5
16
7
17
15
14
4
8
12
11
9
13